If a man empties his purse into his head, no one can take it from him.—FRANKLIN.

CONTENTS FOR OCTOBER, 1943

SCHOOL SCIENCE AND MATHEMATICS

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RAY C. SOLIDAY, BUSINESS MANAGER

SCHOOL SCIENCE AND MATHEMATICS appears this month with the name of a new business manager, Mr. Ray C. Soliday, P.O. Box 408, Oak Park, Illinois. Mr. Soliday has now been in charge of the business office since early in July. We hope that all subscribers and advertisers will note and record his address. This is our first change in business address for more than fourteen years.

Mr. Soliday is well known to all members of the Central Association of Science and Mathematics Teachers for his excellent work as Secretary and as Chairman of the Membership Committee for several years. His interest in this organization began in 1930 when he joined the faculty of the Oak Park high school. Since then he has been one of our most reliable workers but has also found time to take part in other professional activities, serving two years as President of the Illinois Association of Chemistry Teachers.

For his life's work he has made special preparation, graduating first from Eureka College and later from Illinois University with the Bachelor of Arts degree. His Master of Arts degree was granted at Columbia University and he has had further graduate study at the University of Chicago. His practical experience includes work in Manufacturing Control, Public Relations and Personal work. At present he wears the uniform of his country in the Chemical Warfare Procurement work with headquarters in Chicago. His assignment is Assistant Executive Officer, Chicago Chemical Warfare Procurement District.

If your copy of SCHOOL SCIENCE AND MATHEMATICS does not reach you, please notify Mr. Soliday.

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

A WARTIME CONFERENCE

The Forty-Third Annual Convention of the Central Association of Science and Mathematics Teachers is scheduled for Friday and Saturday, November 26 and 27, at the Palmer House in Chicago, Illinois. Thus, for the second successive year, the Annual Meeting of the Central Association will be held under wartime conditions.

As never before, the war has emphasized the critical importance of adequate training, both fundamental and advanced, for American youth in the fields of Science and Mathematics. The armed forces, the vital war industries, and the necessary civilian services require a higher degree of sound technical education than at any time in the history of the Association. This increased emphasis is not a surprising development to teachers of Science and Mathematics who always have been aware of the worth of their subjects, but it has served to bring about a wide realization, on the part of the public of the need for scientific and mathematical education. This period of increased emphasis, while it is a period of great opportunity, is also a period of grave responsibility. Teachers have an obligation to their country and to their students to perform their jobs better than ever before. Students, in many instances, enter the armed services directly from the classroom. The success with which teachers of Science and Mathematics carry on their work of instruction plays no small part in determining how well their students will be able to serve America.

It was with the above thoughts in mind that the programs for the 1943 Convention were planned. The meeting has been organized to crowd into the time available as many significant programs as possible. Speakers have been scheduled to discuss important topics that should aid teachers to understand better the meaning and scope of wartime teaching problems. Friday morning, the Convention Keynote will be sounded by Mr. Merwin M. Peake, Chief, Civilian Pre-Induction Training Branch, Army Service Forces. Mr. Peake's subject is "Pre-Induction Courses in Science and Mathematics." He will be followed by Professor William A. Albrecht, Chairman, Department of Soils, University of Missouri. The title of Professor Albrecht's

lecture is, "'Grow' Foods or Only 'Go' Foods According to the Soil." Professor H. C. Carver, Department of Mathematics, University of Michigan, concludes the morning session with a significant talk entitled, "What Air Navigation is Not." The Annual Luncheon is planned for Friday noon. Dr. Luther Gable, instructor in the U. S. Army Signal Corps, is to be the guest speaker. Dr. Gable has arranged to present a Demonstration Lecture the subject of which is "Electromagnetic Radiations." Saturday morning, the General Session will be addressed by Lt. Colonel William O. Brooks, Chemical Warfare Service, Washington, D. C. Colonel Brooks will discuss the "Work of the Chemical Warfare Service."

In addition to the General Sessions the section chairmen have arranged timely programs for Friday afternoon and Saturday morning. A few of the prominent specialists who have graciously consented to take time from their important teaching and research duties in order to speak on the Section Programs are: Dr. Herman Schlesinger, Head of the Chemistry Department, University of Chicago; Dr. Harold G. Shane, State Supervisor of Elementary Curriculum for Ohio; Dr. James A. Reyniers, University of Notre Dame; Dr. E. T. McSwain, Northwestern University; Dr. Robert Havighurst, University of Chicago; Professor I. Owen Foster, Indiana University; Dr. John T. Johnson, Chicago Teachers College; Professor Harold Thayer Davis, Northwestern University; Mr. Eiffel G. Plasterer, Huntington, Indiana.

Since the Convention is designed to make an important contribution to wartime education, it is the desire of the Board of Directors and the Officers of the Association that the fruits of the conference be made available to as many teachers as possible. Consequently fifty-cent guest convention tickets will be offered to non-members. Holders of these tickets will be able to enter any and all convention meetings. Teachers should plan early to attend. Because of wartime conditions, travel and hotel reservations ought to be made soon.

The 1943 Association Yearbook, carrying complete Convention Programs, is published early in October. Members will receive their copies through the mail. Non-members may obtain complimentary copies by writing the Yearbook Editor, Professor J. E. Potzger, Butler University, Indianapolis, 7, Indiana.

GEORGE K. PETERSON, *President*

FRANKLIN T. JONES

Franklin T. Jones, the oldest departmental editor of SCHOOL SCIENCE AND MATHEMATICS, passed away at his home in Cleveland, Ohio, June 4, 1943 at the age of sixty-eight years. Mr. Jones served as editor of the "Science Questions" department from February 1905 until his death.

He received both his Bachelor's and Master's degrees from Western Reserve University where he was elected a member of Phi Beta Kappa. He later studied at the University of Chicago.

Mr. Jones began his teaching career at South High School, Cleveland, where he taught physics from 1900 to 1904. From 1904 to 1918 he had charge of the mathematics and physics teaching at the University School, a private high school in Cleveland. After leaving the University School he became supervisor of the Apprentice Schools at the White Motor and the Warner Swasey Companies, both of Cleveland.

It was while he was at the University School that he began publishing *Question Booklets* compiled from college entrance examinations on mathematics and science. Later he included other subjects such as language, history, and English.

All during his teaching career and until his death he was an active member of the Central Association of Science and Mathematics Teachers. He served as its fourth president in 1908.

Although in later years he left the teaching profession for a business career his interests in science and mathematics never waned. His dynamic methods of presenting scientific materials encouraged many of his students to select the scientific field as their life work. He not only lived science in the class room but at his home as well. As evidence of this fact his two sons both secured Ph.D. degrees, one entering the field of chemistry and the other became a physicist while his daughter is a teacher of home economics.

The death of Mr. Jones is a distinct loss to science as well as a loss to this magazine and to the Central Association of Science and Mathematics Teachers.

ERNEST O. BOWER

Life being very short and the quiet hours of it few, we ought to waste none of them in reading valueless books.—Ruskin.

SCIENCE PROJECTS FOR GIRLS

FLORENCE HARRISON
Niles Township High School, Skokie, Ill.

Perhaps the daughters of factory-working mothers will in the future have work shops equipped with tools, which they may use; perhaps they will become concerned about the mechanism which makes their toys operate. Certainly no girl should be discouraged from building airplanes, planning electric circuits, constructing mechanical models, or making a telescope. The freshman girl is rare indeed who really enjoys doing these things. Her interests and play experiences differ from those of her brothers. "I could never do that." "Where did he get those parts?" "Who wants to play with batteries." Ideas such as these express the attitude of girls relative to science projects as boys think of them. Yet, girls do like to do things.

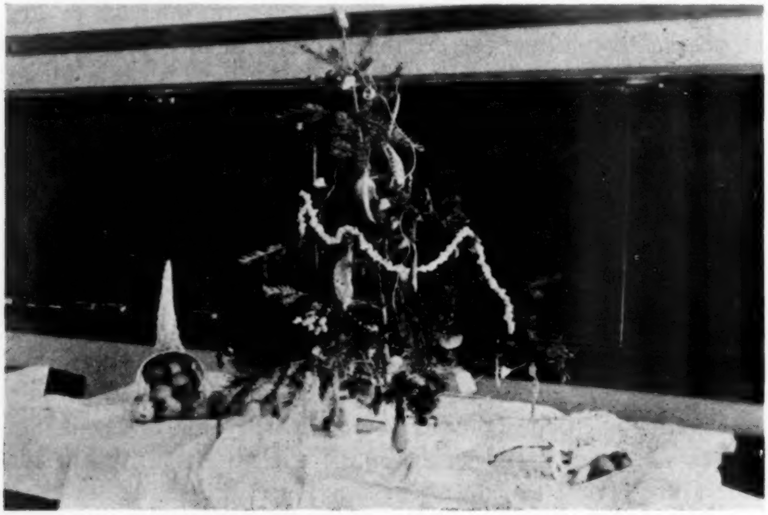
As teachers, it is our responsibility to suggest science activities which girls as well as boys will be interested in. Reading, writing articles, making posters, clay modeling, making charts, booklets and diagrams appeals more to the girls.

Have you tried a science book-club project? In every library there are books related to various fields of science of which students are unaware until they begin exploring. Twice during the year we meet as a book-club to share with each other the things most enjoyed in the book each has read. Not a textbook but stories of animals, insects, flying, starcraft, inventions, and biography, written in an understandable, interesting style are most desirable. It is a real pleasure to see how thrilled some of these readers are about Madame Curie, Clara Barton, Louis Pasteur, and Leonardo DaVinci once they have discovered the great moments of their lives. Who doesn't enjoy reliving a trip with the Martin Johnsons through the jungles of Africa or soaring in imagination for "The Fun of It" with Amelia Earhart? There is romance in wires and test tubes once a student experiences the thrill of knowing their importance in our daily living. Since this is primarily a reading for pleasure project, students should be encouraged and guided in their selection until they find a book interesting, enjoyable and within their own reading ability.

There is a challenge in doing something different. A vitamin mineral Christmas tree proved to be a worthwhile project for our girls this year. Finishing our unit on food about Christmas,

one of the classes conceived the idea of decorating a small Christmas tree with such fruits, vegetables and ordinary foods as contain vitamins and minerals.

First the class prepared a chart showing the important minerals and vitamins found in the available foods to be used for decoration. Each girl brought certain items from home. Capital letters from the macaroni alphabets were selected to represent the vitamins. Some letters were dyed in red cake coloring to represent the minerals as Ca for calcium. This was a beginning in chemistry. These letters were pasted on the various orna-



ments according to the chart which had been jointly prepared. A capital C for vitamin C appeared on the orange, lemon and tomato. A tiny bottle of milk carried the C and D insignia. Green yarn and wire served to fasten the ornaments to the tree after the colored lights had been adjusted.

The pupils were amazed to find the results more attractive than they had anticipated. A star of prunes, a banana inscribed with Merry Christmas, a lemon with a Hitler face and forelock, and a Peanut man gave evidence of pupil ingenuity. Rosy apples, golden oranges, wax beans, nuts, peas in the pod, raisin and cranberry chains, vied for attention. A carrot ornament topped it all. Santa made of apples, with marshmallows, and raisins, traveled over the cotton snow. On the other side of the

tree, Mrs. (Onion) Santa guarded a horn of plenty. The actual decorating of the tree required only one period.

The real learning value came in the planning and preparation. For some, seeing was believing. The next learning value came in the preparation of a news item for the school paper. There could be only one best selection for the paper though many were very well done. The six best were read to the class; their merits discussed briefly in the light of newspaper standards, interest, style and conciseness.

Pupils like to help plan their work. Our play writing project was one of those pupil suggestions which just grows once it gets started. In a class committee meeting someone said, "Why can't we review our work on foods by writing a play?" So they began. Someone else suggested that they write a challenge to the other science classes to compete with them and that the best play would be given over the public address system. Not everyone responded for play writing is not the easiest type of project. In each class the finished plays were read and the two best plays selected by student vote. This resulted in six possible choices.

One of the class presidents asked the dramatics teacher to select the winning play. She selected two, one for its interesting style and the other for its content. The result was both girls rewrote their plays, one for greater interest and the other for more content, and both playlets were used in a freshman assembly.

If you are looking for a project which will provide for the personal interests and individual abilities, you may be interested in our research project. To be sure the word research cannot be used here with all its scholarly implications. To the beginning science student, it is research which presents a real challenge with plenty of opportunities for self expression; it is a project which grows from year to year.

Early in the fall each class is presented with a long list of suggested science topics to which they are free to add others. They are given about two weeks to explore the possibilities and determine their preference according to their personal interests. Two girls frequently like to work together on the same project. This may or may not be wise, but it usually makes it more interesting for the students.

The subject chosen then becomes her research topic for the year. She will have an opportunity to become acquainted with the library facilities. She will have to use newspapers and magazines for information and illustrative material. Most of the work

will be done out of class period. Several class periods should be used by the students working in the library under the supervision of the teacher. Freshmen need lots of help in locating material. The librarian was asked to give a lesson in the use of the reader's guide, card index, and arrangement of material in the library. Learning to take notes, writing letters for free materials, visiting a museum have their own educational values.

Plans must be made for presenting each topic for the benefit of the group. Talks, booklets, posters, charts, scrapbooks, slides, models, any devices which will help to present information in the most interesting manner are encouraged.

When the projects have been completed, class committees arrange the materials, as a minature exhibit, grouping all work related to a certain topic as a unit. A day or two is set aside for sharing the results of our research in each class.

If you are willing to do a little extra work, if you are anxious to become better acquainted with your pupils, if you want to help them develop their individual interests and capacities, you will welcome every opportunity for special projects. Before choosing a project local facilities must be considered. A good beginning on any project will have a good ending proportional to the availability of materials and the degree of encouragement, guidance, and continuous effort on the part of the teacher to stimulate pupil activity.

SOYBEANS FOUND TO CONTAIN MORE VITAMINS THAN WHOLE WHEAT

Soybeans, which are being boosted as a supplement to our rationed wartime meat supply, have been found to be good sources of a number of vitamins, in analyses made by Prof. Paul R. Burkholder of the Osborn Botanical Laboratory at Yale University.

Prof. Burkholder determined the percentages of seven vitamins in six of the soybean varieties commonly cultivated for human food. He found no great differences among the varieties, but he did discover that most of the vitamins tested change in concentration as the beans ripen. Thus, thiamin, often called the morale vitamin, is more abundant in ripe beans than in green ones; whereas riboflavin has higher concentration in the green beans. This may eventually be a matter of dietetic importance, since the beans can be eaten either way.

Prof. Burkholder also compared the vitamin concentrations in soybeans, lean beef, lean pork and whole wheat. In all but one (niacin), the beans had a decided advantage over the wheat, and as sources for most of the vitamins they were able to compete on at least even terms with the two kinds of meat.

CRITICAL THINKING ABILITIES AND INSTRUCTION IN MATHEMATICS*

PAUL L. TRUMP
University of Wisconsin, Madison, Wis.

We are all becoming increasingly aware of the demands being made on mathematics and science for an essential contribution in our bid for victory in this war. We view with satisfaction the reactions of the general public to the pleas of representatives of industry and of the military for more extensive and intensive training, for more boys and girls, in basic mathematics. Advertising agencies are capitalizing on this public awareness. As you page through any of the current magazines which have been leading outlets for advertisers you will see evidence of this tendency in their emphasis on technological problems.

It is a commonplace to observe that war activity serves to accelerate and amplify certain trends which are already present in a social order. In many areas developments, which would under normal circumstances occur over a period of years, are condensed into a period of months. A comparison of emphases and problems of the last two world-wars gives much insight into social and industrial trends in important aspects. We cannot, this time, make the mistake of assuming that after this war is over we can revert back to things as they were before. The world changes, and tomorrow is what it is because of today! We can expect many and drastic changes in all aspects of living! The future role of government in education is only one of the important question marks which complicate the problem of anticipating the future.

We dare not revert back to an attitude of complacency that springs from a feeling that our problems have been solved for us—that Mathematics has finally come into its own and will be welcomed with open arms by educational administrators and guidance officers in our high schools. There is even now a distinct opposition to the increasing of time for mathematics instruction in our schools. Many are skeptical that more of what we have had is the answer to our problem. They demand a different kind of mathematics, not simply more mathematics.

I do not believe, however, that that is quite what they mean. The formula $y = ax^2$ has the same meaning whether it applies to

* Presented at the Mathematics Section of the Central Association of Science and Mathematics Teachers, Nov. 27, 1942.

the relation between area and radius in a circle or to the relation between lift and air speed for an airplane. The process of adding $\frac{1}{2}$ and $\frac{1}{8}$ is the same in an arithmetic class as in a factory. The armed services and industry alike are calling for honest-to-goodness mathematics of the kind we've been teaching. Their chief concern seems to be that more boys and girls should be guided into such courses. They have been quite charitable in their confidence in us to do the job. They are willing and anxious to assume for themselves the responsibility of special training in particular applications. They are, no doubt, being realistic in taking this stand.

There are two points of view which we must keep in mind. One involves the concept of training, or of mathematics as a tool subject. The other involves the concept of mathematics as a part of general education or as a method of thinking quantitatively. We believe the mathematics we have been attempting to teach is, in the main, the mathematics which is so vitally important today. We must admit, however, that there is a wide variance between the mathematics we attempt to teach and that which pupils learn. Some of this variance can be blamed on us.

The emphasis, and perhaps the need today, is predominantly on the training aspect of mathematics. There is concern for refresher, or survey, or telescoped courses to develop knowledge and technique. No doubt we shall learn much in trying to make the training aspect of our courses more functional. We shall find that we can be much more efficient than we have been in developing specific skills and knowledges. Increased emphasis on inductive and experimental or intuitive approaches to understandings in plane geometry, for example, will give results. A careful analysis of curriculum materials will result in omissions and additions.

A few additions and points of increasing emphasis are with respect to scale drawings—representation of velocities and forces by directed line segments or vectors—concepts of ratio, proportion and variation—numerical trigonometry—precision and accuracy in measurement, tolerance limits, significant figures, various new units of measure as mil measure of angles—mapping, longitude, latitude and time—comprehension of large and small numbers—reading, interpreting and constructing graphs and tables, statistical concepts—reading instruments involving many variations in type of calibration and the use of the vernier—center of gravity—the slide rule and logarithms.

We can and must adjust very rapidly to this type of change. The immediate problem is to provide trained personnel to win the war and that, I am confident, we will do well. It is with respect to the second emphasis, however, that which goes beyond the immediate skill aspects of mathematics, in which we find the more difficult—though none the less important—problem.

An objective in the teaching of algebra is the maintenance and development of arithmetic skills. We have sabotaged this effort, however, if care has not been taken that the nature of number symbolism and the meaning and procedures attached to the operations of arithmetic have not been taught from the beginning in a form which is consistent with their mathematical bases. It is one thing to conclude by experiment that multiplication by 100 moves the decimal point two places to the right. It is quite another thing to understand that multiplying by the square of the base raises each power of the base by 2 and changes the place value of each digit in the number accordingly. Crutches and artificial tricks in arithmetical computations may make more immediate, certain response patterns; but these patterns exist for future use and development and not to be forgotten.

We have crowded instruction in arithmetic skills essentially into a few years below grade nine. We have depended on the meaning and insight with respect to arithmetic processes which we were able to develop on this level. We have taught algebra in the next compartment, being satisfied with some intuitive development of rules and depending on drill alone to fix skills. Too often we develop in students a state of mind in which thinking stops when a formula or equation is obtained. Then we have swung to the other extreme and sought to make the entire course in plane geometry a course resembling somewhat one complete logical unit.

I should like to state some conditions which I believe are necessary, if not sufficient, if pupils are to develop through the study of mathematics desirable habits of relational and critical thinking as well as facility with the tools, skills and knowledges necessary for thinking to take place.

We must accept and carefully define what we believe to be the important abilities involved. This cannot be done on one level of instruction independently of another. It is not a problem for which we can simply build a unit of instruction. The abilities involved in defining a problem, determining what data are nec-

essary, obtaining or supplying the data, presenting the data in various forms, studying the relationship involved, describing these relationships in various ways, distinguishing between tentative judgments and judgments definitely implied, are aspects of critical thinking which must have constant emphasis. If they are important, they must be developed through a study of meaningful problems. We must guard against assuming that correct patterns of response are necessarily evidence of the growth for which we hope. We can very easily merely introduce a new series of temporarily automatic responses based, not on insight, but on meaningless generalizations.

This does not imply that all work in the mathematics classroom can be directed toward such procedures as conducting community surveys and measuring flag poles. There are, however, some ideas so important that we can afford to take much time and care in developing them. Without them, time supposedly spent efficiently, is wasted.

This implies a consistency and continuity in emphasis on all levels of instruction—an emphasis carefully directed toward those values we deem important. We can overdo the philosophy that each course constitutes a terminal course and is independent of future work. There can be no terminal course, but each year of experience must take the child as far along the road as he is able to go.

Bringing into the classroom, problem situations from aeronautics, industry and the military which involve applications of mathematics, should serve as an opportunity to develop a desirable emphasis. Abstract mathematical principles of relationship can be made meaningful only through many illustrations and applications. These principals must be brought out of the realm of verbal facility and into the realm of meaning and understanding.

Some applications will be brought into the classroom because of their specific value for our particular pupils. The vocational training aspects of mathematics are becoming of increasing importance. There is a more vital purpose involved however. An application implies that something is to be applied. This something may vary in specificity from a mathematical skill, as in the case of a computation with the use of a formula, to an understanding of the type of relationship involved in a mathematical formula. The promising emphasis is the use of the problem situation as an aid in developing, or extending, the understand-

ing applied. Too often we have utilized such problems merely for motivation or as an excuse for more drill in the mechanical skills involved. Students can be taught to make responses which are correct but not meaningful to them, even in the specific situation. The area of a square varies directly as the square of a side. The lift of a plane varies in the same way with the plane's air speed. It is a long jump, however, from an ability to visualize the comparison in area of two squares of differing dimensions, to that of appreciating the respect in which plane speed and lift represent the same type of relationship. The formula, the table, the graph, and an understanding gained through insight into the nature of the situation must be coordinated. The pupil must understand what makes an airplane go up—what factors are involved and which will we hold constant at the moment—what type of experimental evidence could be obtained to discover relationships—what are various ways in which these data can be presented to reveal relations—how can these relationships be described or expressed—what are some of the implications of the results obtained?

The mere statment that a certain type of relation holds in a particular situation and a list of exercises involving the application have meaning only after the concept has formed. Applications introduced for the illustration of something learned for the purpose of further development can be handled differently from those upon which we depend for initiating the understanding in the first place.

Mathematics is an abstract and consistent science. These properties account for its fundamental usefulness in all areas. It is a measure of progress in human thinking in any area when that thinking has developed to the point where it lends itself to mathematical statement. The demands of mathematical thinking are exacting. We are familiar with often repeated statements to the effect that, in mathematics, a statement is either right or wrong—that personal opinion has no place and personal points of view must be left outside of the mathematics classroom. This is a stimulating and satisfying point of view for some. It is a deadening factor for others. In many instances, initiative and confidence are destroyed.

The mathematician does not proceed in his initial investigations by pure, cold, logical steps of implication. "Hunches" are an important aspect of research in mathematics. Some prove fallacious but may lead to the discovery of a relation which

eventually gives mastery of the problem. The process of providing the logical pattern is often the last step.

Perhaps we need to introduce more experiences in mathematics which encourage tentative judgments. In the process of interpreting the data presented in a graph we are frequently satisfied with emphasis on interpretations which are definitely implied by the data.

Interpretations of data based on reasonable interpolations, extrapolations, cause and effect relations, analogy, sampling, and the like are judgments which are frequently made unconsciously by all. Tentative judgments should be encouraged, but knowledge of their tentative character must not be lost sight of. If these types of judgments are encouraged in connection with problems of immediate concern, the processes of mathematics for many begin to take on a human aspect. Mathematics is, after all, man-made in its entirety.

In an instructional research program during the past year at Wisconsin we enlisted the cooperation of mathematics teachers in a group of high schools around Madison. The teachers were called in and we discussed together some of the abilities involved in interpreting data. A rather specific analysis of certain of these abilities was prepared and placed in their hands. Lesson units for instruction were prepared and likewise distributed. The lessons were based on such problems as what does it mean to grow up, involving data on changes of a physical character, changes in interest patterns in reading and social activity; the problem of vocational choices; and the problem of the family's budget involving factors of employment trends, cost of living trends, wage trends.

I had hoped to give you at this time a substantial report on the results of the study. The rush of major emergency problems of the past few months has made it impossible to complete the analysis necessary for such a report. We found the pupils and teachers interested; we expect to find conclusive evidence of growth. We conducted a series of pupil interviews as a result of which I believe we shall be able to say that pupils are at a loss in making many basic judgments which are implied by the data and at a loss to support intelligently many judgments which they do make.

The teaching of geometry presents on interesting situation. Postulational thinking may result in the discovery of some relationship in geometric figures. Many of the relationships of

interest in geometry for most students, however, can be developed more efficiently by experimental or intuitive means. In general, in fact, it seems desirable to develop an understanding of the nature of the relationship before proof is attempted. The value of demonstration probably lies in the activity itself and as such should be the emphasis. Perhaps the abilities involved in the nature of proof can be developed more efficiently if certain units in geometry are taught with that as the chief emphasis. It is not easy to understand how one can *develop* insight regarding thinking patterns except when there is complete mastery of the situation in which thinking is to take place. The alternative is the province of one whose ability has been developed. Neither can insight be gained in situations in which it is difficult to see that the implication to be established is any more deserving of proof than the assumptions upon which the proof is based. In this connection, I should like to raise the question: Can the true nature of postulational thinking be adequately appreciated except in instances where the assumptions are not statements which, in spite of the teacher, the pupil accepts as self-evident truths?

The development again of abilities involved in aspects of critical thinking in this category cannot be relegated to a one-year course in plane geometry. We have made much progress in achieving continuity with respect to knowledge of basic geometric facts. The problem with respect to other less tangible abilities is, of course, more difficult.

One of our major problems in this area is that of teacher education. Mathematics departments in our teacher-training institutions have driven many teachers to do graduate work and take degrees in Education rather than in Mathematics. Sound subject-matter background is indispensible for the putting into practice of many of the worthwhile experiences learned in connection with professional education courses. Without it many worthwhile ideas are not only useless, but sometimes harmful. The problem of mathematical training for teachers is not, however, the problem of training the research mathematician. Much of the development in the teaching of mathematics depends on the host of teachers in the classrooms. The point of view the teacher brings into the classroom is the dominant influence. This is not simply a question of training teachers how to teach mathematics, but also a question of how to train teachers in the mathematics they will teach.

PHYSICS AND MODERN WARFARE

James W. Moody

Chicago Teachers Review School, 32 W. Randolph St., Chicago

Some weeks ago, a young lady asked me in what way Physics would benefit her in her chosen profession. Upon questioning, I found that that profession was embalming. That same evening, your Chairman asked me to address this group on Physics and Modern Warfare, almost the other extreme, embalming calling for little physical science, while modern warfare is the acme of applied physics. Incidentally, I must have convinced the young lady that physics had some value even in embalming, as she registered for the course.

Of the navy, I have little first hand information, but there the importance of physics seems to be fully recognized, since in a recent poster received by me for the navy detailing advantages of enlistment and giving twenty-six available ratings, for all the ratings listed, physics and mathematics were either prerequisite or advocated preliminaries.

In the army, let us consider for a moment how physics may enter into the functioning of a soldier. Take Sam, Jr., a military candidate—enlisted, drafted, or prospective officer—for example. W.D. A.G.O. Form 63 is probably Sam's first accomplished form, and it will appear often in Sam's service record. Sam is notified to appear at Army Service Command Headquarters for physical examination. Form 63 is the official record of this examination. After various physical characteristics are recorded, the medical officer proceeds to take Sam's blood pressure, using a sphygmometer, a manometer, to the every day physicist. A technical sergeant X-ray's Sam's chest, and an army nurse takes a cardiogram of the functioning of Sam's circulatory system, all of this being recorded on Form 63 or attached thereto. The instruments used are examples of the application of well known physical principles and developed in physical laboratories. As Sam proceeds with his military training, his contact with the science of physics becomes closer and closer, but time does not permit more than a superficial consideration of a few instances.

It is in aviation that the science has had the most pronounced effect. Conservatively estimated, military necessity has speeded up improvement in aviation at least five hundred percent over what might have been expected in peacetime. I need but point

to the wind tunnel and the test cell and their use in the analysis of flight as examples of the application of physics to modern airplane design and operation.

In the Air Service there are eight general sections: pilot, navigator, bombing, engineering, armament, communications, meteorological, and photographic. For the first three, candidates are given a screening test, and although no formal physics is required, a good knowledge of physics is essential and in the succeeding training a thorough grounding in physics is included in the schedule. In the remaining five, advanced physics is absolutely necessary.

Consider communications. There is a military maxim that a mobile force depends upon transportation, supply, and communication, for successful operation, and the severance of any one is fatal to that force. Witness the North African campaign, its objectives, how obtained, and why. How many Signal Corps Schools there are in the United States, I do not know, and the number of students is a military secret, but each of you can judge for himself by walking down Michigan Boulevard and noting the number of buildings devoted to Signal Corps activities. Communication is applied physics.

I mention the advance in aviation. A new offensive weapon requires a counter-defensive weapon. The best defense against aircraft is aircraft. However, anti-aircraft artillery comes a close second. Anti-aircraft artillery is a highly developed example of coordinated applied physics. The time enemy aircraft are within range is exceedingly small, too short for the personnel to do the mathematical calculations necessary. Range finder, sound locator, searchlight battery, and fuse cutter are all electrically connected to a device which does all the calculating and transmits the results to the guns, so that for the short time the plane is within range, all the gunners do is to keep the pointers on their indicators synchronized, while the rest of the gun crew feed shells to the gun at the maximum speed. Changes in elevation, deflection, range and correction for other variables such as speed, change in direction, etc., being taken care of by the nerve center, the comparator. The operation of a modern United States anti-aircraft battalion is a sight to behold, made possible by advanced physics.

Another branch of the Air Service previously mentioned deserves more than passing consideration—the Meteorological Section. This branch is just coming into its own in recognized

importance. Developed from a private meteorological service, it is now headquartered at Washington. It cannot tell you what the weather will be at a particular time and place, but it can tell you some time ahead when you may expect a particular type of weather, not quite the same. Primarily limited to the United States, it is rapidly being extended to the war zones, and the knowledge of the time suitable weather may be expected has become essential to successful aviation. So important has this become that the Air Service will shortly announce a new type of enlistment embodying the longest and most advanced academic training, so far, in the Army—twenty months of intensive work. This Aviation Cadet "C" twelve months pre-meteorological training, followed by eight months of advanced intensive training in graduate Schools in Meteorology. The conclusion of the course leads to a commission as Second Lieutenant in the Air Corps Reserve. Prerequisites to the course are outstanding ability in mathematics and physics, no formal graduation from college or high school being required. Further information regarding this course, if not already released, will be found in the press in the near future.

For the few remaining minutes, I am going to take the liberty of changing the title of this short talk to "Modern Warfare and Physics," and from now on my remarks will apply equally to any college subject. It will affect us very materially as teachers and it behooves us to read the signs and adjust ourselves accordingly. All signs point to the fact that by July 1943 "college as usual" is out, since almost all of the men of college age will be in the army or navy. There has been an official feeling that colleges have been somewhat of a means of evading military service for large numbers of young men of draft age. All this is slated to be changed. Apparently men selected to go to college are to be detailed there from active military service. They will be selected on the basis of a military estimate of their aptitude and ability, and the military demand for specialists and technicians. Ability to pay for a particular type of education will not be a factor, since the Government will be footing both the educational and living expense bill.

The army and navy will designate the particular courses each student must take, the choice being neither his nor that of the college. The services will emphasize their own needs. At present, the greatest need is for doctors. The probability is that the seven to nine years required for normal peacetime training

will be reduced to a minimum and the premedical requirement eliminated. Another pressing need is for engineers. The army is reported to believe that in one year of intensive study a man can obtain the basic knowledge needed by an officer in Engineers. Many of those selected for training would no doubt have had some previous engineering education or experience. Liberal arts courses will be drastically cut, if not eliminated altogether. Again I say, "college, as usual" is out. Colleges for military use will be selected because they possess the plants and facilities for fitting into the military program.

At present, almost half a million students in schools and colleges are in the enlisted reserves or assigned from active military duty. Planning calls for all male students after this year to be members of the armed forces. It behooves us, as teachers, to keep our ears close to the ground, to be prepared for drastic adjustments, both in technique and subject matter, and to anticipate as much as possible, with the information as it becomes available.

Physics will ever be a vital subject in education, civilian or military. Today we are at war, an all-out war, and we must govern ourselves accordingly.

NEW X-RAY USE FORECAST

The production for the first time of 100,000,000 volt X-rays through use of the new giant induction accelerator of the General Electric Company promises to usher in a new era of X-ray utilization.

In one stupendous step from about 2,000,000 volts to fifty times that potential, X-rays of a new sort with extraordinary penetration will now be available, first for experimental work and then for industrial and possibly medical use.

The scientists operating the new machine have noted that it may be easier to protect people against the hundred million volt X-rays. This is possible because whereas the lower voltage X-rays are spread out fan-like, the super X-rays are produced in very narrow beams. No one yet knows just what the world's most powerful X-rays can do.

The induction accelerator, or betatron, as it is also called, operates on a principle different from the customary X-ray tube now in wide industrial and medical use. Developed by Dr. D. W. Kerst of the University of Illinois, the induction accelerator was first built in a 2,300,000 volt version and then as a 20,000,000 volt machine which was turned over to Dr. Kerst and the University of Illinois for research use. Meanwhile construction of the 100,000,000 volt machine was hurried along as fast as more urgent war work would allow because of the expectation that the X-rays it makes possible might prove practically useful in inspection of large metal castings.

PRACTICAL BIOLOGY FOR GIRLS*

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The trend in recent times in education is to rethink each subject matter field to find what it has to offer in meeting the needs of young people in the democratic society of America to-day. Now that courses of study are considered viable and adaptable we think of the organized course as being more of a card file constantly being changed instead of a black and white bound book of rules and objectives to be followed literally by page. No item of subject matter should be included as desirable in a course unless we ask "desirable for what purpose?"

The Committee on the Function of Science in General Education of the Commission on Secondary School Curriculum which was established by the Executive Board of the Progressive Education Association to study the fundamental problems of education at the secondary level made a study of adolescents to discover the problems, interests, concerns and inclinations of young people in reaction to the situations which confront them in home, school, community, and the wider social scene.[1] The proposals that resulted are designed to have bearing on the science education of all young people between the ages of twelve and twenty whether or not they are going to college.

The needs of American young people are classified by the committee into four groups: (1) Personal Living (2) Immediate Personal-Social Relationships (3) Social-Civic Relationships and (4) Economic Relationships. It must have been difficult to draw the line clearly between the groups in considering some of the drives of boys and girls. In the following comments the needs expressed in the first grouping, those of personal living, only will be considered because lack of time and space will not permit a long discussion and because this group of needs seems most inclusive of the pertinent interests and desires of adolescent America.

It may be said the adolescent has five major needs in personal living: (a) need for personal health (b) need for self assurance

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* Presented at the Biology Section of the Central Association of Science and Mathematics Teachers, Nov. 27, 1942.

[1] Committee on the Function of Science in Secondary Education, *Science in General Education*, D. Appleton-Century Co., 1938.

(c) need for a satisfying world picture and workable philosophy of life (d) need for a range of personal interests (e) need for aesthetic satisfactions. The purpose of this discussion is to show how certain subject matter was chosen to fill the needs of personal living in a technical high school for girls and how the techniques and projects used are applicable to the lives of girls. The needs of the adolescent in any given community will vary to a certain degree as will the needs between the sexes.

After the most useful subject matter has been chosen one needs to survey the whole school curriculum to find if in the courses of study of other subject fields emphasis is being given to certain phases which will not need to be stressed so much in the biology class as it would be in a school where the curriculum is not so well integrated. Technical schools have long been attempting to meet the needs of the student in a practical way so that now all courses have incorporated very practical projects. We have in modern education broken down the subject lines as much as possible and are trying to meet the needs of the student wherever it seems best to introduce the project.

No one questions the need for maintaining health at a high level. Physical and mental health will include certain habits, attitudes and factual information plus activities, satisfactory living conditions resulting in a healthy body and certain characteristics of personality. The physical education and home economics departments are also hoping to accomplish perfect health for all the student body so we work together toward this goal. Some students will worry, will retain certain undesirable habits, will not apply rules to their own lives even when they know perfectly the factual material. This behavior will bear further analysis as it may be evidence of poor sleeping conditions, excessive fatigue, after-school job, may just be trying to act adult or is suffering from some inferiority feeling or other conflict. The alertness of the teacher in trying to locate the cause of poor mental or physical health through observation of the individual or in private interview is often the diagnosis needed which does not show up in a fact test or a physical examination. Facts about health do not necessarily induce the desire to follow certain habits but advertisers have found the secret. The appeal is pep, beauty, social success resulting from feeling well and wholly alive instead of half alive. It may become the duty of the biology teacher to enlist the aid of the teachers in several departments to aid in teaching a unit as well as to teach scientific

facts. Home economics teachers have tried to improve the diet and posture of students as have the physical education and science departments. Reading what the authors of textbooks say concerning the proper diet does not make a taste appeal to young folk who have declared themselves as not liking certain vegetables or fruits or milk. Knowing what cabbage contains in the way of vitamins and minerals and that it is a cheap vegetable does not necessarily make one like the taste of cabbage which has been overcooked and unseasoned. Once the taste has been offended by a poorly cooked vegetable many never try it again and therefore never have the opportunity to eat it properly cooked and palatable. The home economics teachers serve a vegetable lunch to their classes in home arts—ten-minute green buttered cabbage, *golden buttered* carrots and green beans. The girls prepare the vegetables, cook and season them according to directions and serve them at an attractive table and eat them with pleasure. Did you ever find a sampling of thirty-two persons who were all said to like to eat those three vegetables? We biology teachers are trying to improve the diet of our students but it cannot be done entirely by reading textbooks and feeding white rats.

In the nursery school it is too bad when one is not hungry enough to eat one's vegetables because that day there is a pretty jello or ice cream dessert which of course one who is not hungry cannot eat. This bit of psychology may work on a four-year-old and encourage him to put forth the extreme effort to eat all of the vegetable but teen-age young people make their own decisions in such matters and must feel the urge through taste appeal or an appeal to good complexion, graceful silhouette or something which to them is of paramount importance.

We had known for a long time at Flower that many of our girls were travelling long distances to school and doing the work of the morning without breakfast. We knew they would think more clearly, tire less easily and do better work if they started the day with breakfast but the response always was "I can't eat so early in the morning." Without pressure or argument against this adamant adolescent reasoning we arranged for the lunchroom to serve a ten-cent breakfast of fruit juice, hot cocoa, toast, butter and jelly fifteen minutes before the first-hour class. The early arising and walk in the morning air were good appetizers and a quick meal with friends before going to class

was breakfast which we had not been successful in getting them to eat at home.

Occasionally the plan is made with the lunchroom to bring attention to the trays of the students who have chosen a well balanced lunch. A member of the dietetics classes stands near the cashier and puts a blue ticket on the tray which announces that here is a well chosen lunch if the lunch contains green vegetables or salad or fresh fruit. This project could be planned by the biology classes in a school where the home economics department is not large. Is our problem finished in biology when we teach the academic truth concerning foods and health in general or should we go further and try to see that it is applied?

The need for self-assurance is met at any age when we feel respected by our contemporaries and more talented than most in a certain trait. Exercise, rest, and good posture are important in giving self-confidence and poise resulting in better bodily functions and wider social life. Studies have been made by every biology class to show why good posture makes one's inner organs function better. Some modern teachers use the shadowgraph to illustrate the best postures in the class. This is a very good procedure in showing the class near perfect examples and in increasing the self-assurance of those who are chosen to pose for the shadowgraphs. The furtive glances which women and men make when passing the plate glass store fronts on the street show how they would all appreciate full length mirrors which are actually very seldom found in the average home. The home economics classes with full length mirrors and dresses to be fitted and modelled provides the real incentive for practicing habits which will lead to perfect postures.

Private interviews with individuals who look pale, have many headaches or doze daily in class bring attention of the individual to her own health needs and encourages her to seek medical advice. Those who are victims of acne or nail biting may be referred to the cosmetology teacher who may offer suggestions for improvement. Though her advice may only verify what the biology teacher has already suggested it is worth while when several teachers of different subject fields seem to agree in giving information. Appointment may be arranged for manicures in personal hygiene shop while the cause of the nervous habit is being located.

The symptoms which an adolescent may exhibit which show he is lacking in a satisfactory amount of self assurance may be

in the compensation of absorbing himself in intellectual impersonal occupations. Opportunity to assume more and more mature responsibility satisfies the need for self-assurance. These mature responsibilities can be met in school by management of the laboratories, much freedom of action in planning one's own education, extracurricular activities and the liberty to make suggestions concerning the improvement of teaching in courses. A job and money as the badge of adulthood should be replaced in thinking of the public by attendance at a University and membership in adult groups as being of adult importance. College young people returning for a few minutes' visit with the faculty are the best salesmen for college life if allowed to speak to the class. They look smart, chic and speak a collegiate vocabulary. They talk of campus life, week-end field trips in biology to nearby state parks, laboratories, sports on the campus in physical education costumes appropriate to the sport. Five minutes' conversation with one of them does more toward creating a desire for attending college than what we of the faculty could say about the academic and economic value of a college education.

Survey projects in the school, the home or community are adult in scope and importance. Studies can be made of sanitation, ventilation, diet, and other scientific practices. After a difference of opinion in class over the question, "Is a combination of salt and soda as good to use when brushing teeth as the advertised dentifrices?" a study was made in getting the opinion of one hundred Chicago dentists on the subject. By the time we compiled the results we had forgotten who had started the controversy and everyone seemed anxious to find what the percentages of pros and cons were. The class seemed quite disgusted with those dentists who gave such general answers that one could not deduct a "yes" or "no."

In the work of insects emphasis is placed on household pests and methods of control. The adults in the home are grateful for the help given in control.

The need for a satisfying world picture and a workable philosophy of life is difficult to meet these days when the world is far from satisfactory even to the adults who are to guide the thinking of adolescents. It becomes necessary to fit into this workable philosophy those things which will last and stand the test in a changing age. To know which authorities to accept and which to reject when there arises a difference among several equally respected as parents, teachers, and books concerning

questions of morals and folklore. A large part of the scientific method is the evaluation of authorities and looking for causes. To be armed with the habit of looking deeply for causes is to be protected against superstition, unethical advertising and other forms of propaganda. It gives a weapon which can be adjusted to meet the changing forms of attack. To have interests which are wholesome and which create a bit of beauty for the eye or the spirit is to have a feeling of self assurance and satisfaction. Gardening is emphasized in a project on how living things respond to their environment. A plan is drawn to scale by each girl for landscaping her actual or future home grounds. Victory gardens of vegetables are planned in biology classes and advice is given to the student body and community through articles in the school paper concerning gardening. Plans are made to beautify a window at home with a window garden. With the aid of the camera club photographs of the windows are taken before the plan is made and after the project is completed for north, south, east or west window exposure. A propagation house is set up to root cuttings so that girls may exchange plants. The interest of the family and the comments by friends and neighbors repay the effort expended and bring a feeling of satisfaction to the worker.

Much biology should be taught in the open air. Observing leaf forms, recognizing trees and other plants in various seasons, finding cocoons and birds' nests are experiences which give meaning and pleasure to life out-of-doors especially for city young people who have not known the possibilities of recreation in nature walks. If we who have a love of the world of living things examine from what source we acquired this feeling, I believe, we would feel we did not find it within the walls of a biology classroom but rather as we stood on a woodland path or beneath a beautiful tree appreciating the marvel and beauty of all the processes which the microscope and textbook have revealed and which some good teacher has applied during field trip when the fellowship of all living things seems most apparent.

In the autumn semester we study a problem on how man has produced so many varieties of apples and chrysanthemums from the ancient ancestors. During apple week each biology student brings an apple, preferably an unusual variety. Near the end of the week we arrange an exhibit of the kinds represented (usually at least twenty kinds). Six or seven hundred apples are brought in. An art committee arranges the exhibit, the camera

club takes pictures for our record of activities in the school, and when we dismantle the exhibit we deliver the apples to the Cook County Hospital—Children's Ward. The letter of thanks which we receive from the Volunteer Workers Committee makes each individual glow with pride in the project.

We are then ready to visit the chrysanthemum show when it opens at the conservatory. The classes enjoy the guide service and are familiar with the vocabulary. We arrange the trip to the chrysthanemum show early in the season so that each student will have an opportunity to bring relatives and friends to the show and enjoy telling them about hybridization, mutation, and grafting.

There is a feeling of adulthood and satisfaction in being able to enjoy so thoroughly something planned for the adult public. Then the girls are ready to attend the livestock show in December and understand what they read in the newspaper accounts of the many breeds on display.

Perhaps the subject of reproduction is more easily discussed in technical schools than in coeducational institutions. It seems easier to establish a rapport which will encourage open discussion and frank questions. One cannot imagine the superstitions and folk tales concerning sex with which the world is burdened until you have had a class which is very cosmopolitan representing many nationality groups for the old wives' tales travel down into modern settings. It seems most worth while to encourage open discussions and questions in this unit. Probably never again will these young people be where sex is discussed on an educational and truthful level. It is very important to the adolescent to be scientifically informed on this subject as such knowledge gives a feeling of self assurance and a freedom from doubtful folk stories on the subject. It is difficult to catch a glimpse of aesthetic appreciation in the mind of a sophisticated adolescent. The wide-eyed wonder of the little child is often expressed in the word "Oh." With the adolescent the word "Gee" or "Isn't it funny the way that works?" is almost all the response one can expect in way of verbal expression of the marvel or beauty felt by the individual girl or boy. A written reaction on "How did you feel about the field trip or this unit we have finished or the museum or the study of reproduction subject?" will many times reveal thoughts which are philosophical and more appreciative of the implications involved in the work than would be expected of the adolescent mind. It gives an op-

portunity to voice any felt criticism but it also reveals personal feelings of students who are too retiring in manner to express a thought which is original and might be construed as containing an aesthetic emotion of any kind. Having expressed herself in an enthusiastic manner on paper perhaps much to her own surprise she will probably be a good salesman for the course of study and realize and support its possibilities of worthwhileness. At the end of the year each student is asked to express in writing the best arguments for taking the course she would offer a first year student who was considering electives. The responses show that this crystallizes the thinking of the students on the subject.

Biology, as well as any other subject offered in modern education, justifies its place in the curriculum only so long as it helps to meet the needs of the students of that period of time in a practical way. Perhaps its course will not be taught completely in a biology classroom. We may introduce and experiment and generalize the principles of living things but if we can enlist any other phase of the curriculum in the contemporary high school to make the applications or to aid in impressing the truths, then we are negligent if we do not cooperate with these agencies in teaching—not biology but girls and boys who have real needs.

A NEW SOURCE OF TANNIN

Divi-divi does not have a tannin sound but the divi-divi tree of tropical America grows a divi-divi pod from which divi-divi tannin is extracted to produce a particular finish in American leathers. Larger amounts are now imported into the United States than in pre-war days because of shortages of other tannins which formerly came from war-infested countries.

The divi-divi tree is found in the islands in the Caribbean and in Colombia, Venezuela, Brazil, Mexico and other Latin American tropical countries. Botanically it is known as Caesalpinia coriaria. Extracts from its pods are used for dyeing as well as for tanning. The name divi-divi appears to be of native origin.

The dark brown pods of the divi-divi are from 1½ to 2½ inches long, and when chemically analyzed are found to contain up to 50% tannin. The tannin is extracted by dissolving it out with hot water after the pods have been disintegrated. When leather is tanned with divi-divi alone it takes on a yellowish color.

Most commercial divi-divi tannin is obtained from wild trees. A few cultivated orchards exist, however, and the pods from these are reported to contain a higher percentage of tannin than the wild pods. An orchard tree at eight years of age will produce from 150 to 300 pounds of pods if cultivated under favorable conditions of soil, moisture and climate. It thrives in hot lowlands with a minimum amount of rainfall.

NOTE ON ELECTROMAGNETIC INDUCTION

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The unity and logical development of the subject of electricity would be notably improved if electromagnetic induction were presented as a natural consequence of principles previously established, instead of as a unique and novel phenomenon. Yet, except to students of Maxwell's field equations, induced currents have always been treated as independent of the simple laws of electromagnetism. And no textbook has yet attempted to put $\nabla \times H$ into words for the comprehension of the seventeen-year-old! Lenz's law, to be sure, does connect the *energy* of the induced current with the work performed in producing it; but still the mystery is left: "Why does the current get induced in the first place?"

As a matter of fact, electromagnetic induction is not an unpredictable effect, but can be deduced from a consideration of three laws which to most students seem more "natural," or understandable, than the induction effect. These laws are:

(1) a stream of electrons constitutes an electric current;

(2) a stream of electrons is surrounded by a magnetic field, the lines of which follow circles in the direction indicated by the fingers of the left hand when the thumb points in the direction of flow of the electrons;

(3) an electric current in a magnetic field is pushed sideways away from the side on which its own magnetic field adds to the field which it is in.

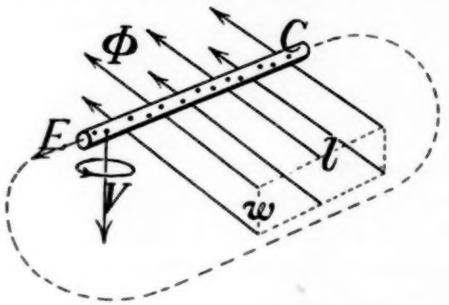
Here, in brief non-mathematical form, is an explanation of why current is induced by the motion of a conductor across a magnetic field. Assume the three laws stated above.

Consider a conductor, C, part of a complete circuit, in a magnetic field Φ, to which it is perpendicular. The conductor contains many free, or easily moved, electrons. Let the conductor be moved in the direction of the arrow V; every moving electron, by law (1), is an electric current. Hence, by law (2), it is surrounded by a magnetic field which, were it not for field Φ, would have the form and direction shown by the small circle around V in the figure. However, field Φ reacts against this field in accordance with law (3), to push the electron stream in the direction of the arrow E. Electrons throughout C are in this

way moved in the direction of E; their flow constitutes the induced electric current.

The cause of induced currents is simply the motor principle, the action being upon free electrons rather than upon the solid conductor usually referred to in illustrating it.

Probably it would not be wise to introduce to beginners the subject of electromagnetic induction in the logical manner described, since it is a psychological truism that young people do not learn well by logical deduction. Nevertheless, before the subject is considered complete, a unification of this sort is desirable. There is a great gain in insight, in a comprehension of



A moving conductor carries its electrons across a magnetic field.

the fact that later in the course becomes of prime importance, namely that the magnetic and the electric fields are but different aspects of the same thing, the difference being due solely to the relative motion of the observer.

For a more advanced course, it would be well to generalize the argument to cover the cause of conductor, field, and motion at any relative angles, and also to make the matter quantitative. This is done by equating the mechanical power (force · velocity) expended in moving the conductor, with induced current flowing in it, across the field, to the product of the current and potential induced in the conductor. The force is $I\mathbf{B}l$, where $\mathbf{B}$ is the induction Φ/wl; the velocity is dw/dt.

$$I\mathbf{B}l \cdot dw/dt = I(d/dt)\mathbf{B}wl = Id\Phi/dt = EI.$$
$$E = d\Phi/dt.$$

Love all, trust few, do wrong to none.—*Shakespeare.*

DEMONSTRATIONS ON SOME INCENDIARY MATERIALS

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Science instructors, participating in certain civilian defense groups, on whom devolve the duties of explaining the fundamental principles of incendiaries and explosions, may find the following elementary demonstration experiments helpful. The writer has used the outline given below as a basis for lecture-demonstrations before numerous groups each member of which was provided with a mimeographed copy. Other simple experiments may readily be substituted or added; the materials required for the experiments are easily available in any chemistry laboratory.

1. Oxygen is necessary for burning.
   DEMONSTRATION: Invert a beaker over a burning candle. The oxygen is soon used up and the flame is extinguished.
2. Greater amounts of oxygen increase the rate of burning.
   DEMONSTRATION:
   (a) A glowing wood splint when placed in oxygen bursts into flame.
   (b) Heated steel wool will burn in oxygen.
3. Before a substance will burn it must be heated to a certain temperature. This "ignition temperature" or "kindling temperature" is different for each substance.
   DEMONSTRATION:
   (a) Carbon bisulfide is ignited when a heated glass rod is held over it.
   (b) Alcohol can be ignited with a match.
   (c) Kerosene has to be warmed before it will ignite with a match.
   (d) The steel wool in Demonstration 2 had to be heated before it would burn in oxygen.
   (e) Magnesium metal can be ignited by heating a crucible in which the metal is placed.
   (f) It is shown that cooking gas from the mains will not burn until it is raised to a certain temperature. (Ignite gas above or below wire gauze held over bunsen burner.)
4. It is not necessary to remove *all* oxygen to stop burning.

Often a small decrease of atmospheric oxygen stops the burning.

DEMONSTRATIONS:

(a) A burning wood splint placed in a vessel in which some of the air has been replaced by carbon dioxide will be extinguished.

(b) Carbon tetrachloride is poured on a burning liquid. By partially excluding the air it puts out the fire.

5. To get an explosion it is necessary to form suddenly a large volume of gas.

DEMONSTRATION:

(a) A gunpowder mixture is exploded and the gases formed are noted.

6. If this explosion takes place with the liberation of heat the volume of the gas is even greater due to expansion, and the explosive effect is greater.

DEMONSTRATION:

(a) The cork stopper of a test tube in which some water is boiled is ejected.

(b) A "steam bomb" consisting of water sealed in a glass tube explodes violently when heated. We have a small explosion in both cases merely by heating a harmless vapor.

7. A good explosive should produce much gas and heat. A good incendiary material might be one that produces much heat. Large amounts of oxygen must be available to produce these effects. Explosives and incendiaries often do not rely on atmospheric oxygen but derive the oxygen from materials contained in themselves. Potassium chlorate, potassium nitrate and similar substances easily yield oxygen and are often incorporated into explosives and incendiaries.

DEMONSTRATION:

(a) Potassium chlorate or potassium nitrate are heated and a glowing wood splint when placed in the oxygen evolved bursts into flame.

(b) When potassium chlorate or potassium nitrate is mixed with powdered magnesium the mixture flares violently when set off by heat or a spark.

8. Some incendiary materials.

Thermit. The thermit bomb is made from powdered aluminum and iron oxide (rust). Under normal temperatures these two substances do not interact. When an explosive mixture

such as demonstrated in 7 (a) is set off the thermit is heated and a chemical change takes place. The important thing in this reaction is that enough heat is generated to raise the mixture to about 4300°F. Because molten iron (melting point 2500°F.) is liberated, a peace time application of this is in welding, and its war use as an incendiary is obvious. The intense heat liberated will ignite any ordinary substance.

Sodium alone or sodium mixed with calcium carbide can be placed in capsules. With moisture the capsule dissolves, the sodium ignites, and the calcium carbide gives off acetylene, an inflammable gas.

Potassium chlorate mixed with sugar will become an incendiary material when a little sulphuric acid is added.

The "English Calling Card" is prepared by soaking paper in carbon bisulfide in which white phosphorus has been dissolved. When the carbon bisulfide evaporates the phosphorus ignites in contact with air.

COFFEE CAN-MAKING TECHNIQUES APPLIED TO FUSE CONTAINERS

Methods used in manufacturing coffee cans, applied to the making of fuse containers in at least one Naval Magazine, have speeded up production by five-fold and decreased cost to from one-third to one-ninth of the cost under pre-war methods, saving over $3,000,000.

Before the new technique was adopted by the Navy, fuse containers were made by hand by sheet metal workers and tinsmiths. After fuses were packed at loading plants, the containers were sealed in these plants by hand-soldering.

Machine methods have now been substituted, the same methods used successfully for years in producing hundreds of millions of cans annually. Machine-sealing is used at the loading plants.

In actual tests the new machine-made, machine-sealed containers are shown to be superior to the old hand-made ones. They keep the fuses in better condition so that they are more reliable in use. They will withstand 15 times the pressure without leakage. No duds result from their use. They have the same reliability as metal containers for perishable foods.

SEWING BY ELECTRICITY

Sewing two or more fabrics together without thread is possible by use of a strip of thermoplastic material along the seam. A nichrome wire replaces the needle of an ordinary sewing machine and a silver contact replaces the shuttle. They are connected by electric current, which makes contact when the needle descends. The fabrics are spot-welded where pierced by the heated wire. A patent for the process has been applied for.

THE OBJECTIVES OF SCIENCE IN THE SECONDARY SCHOOLS OF THE UNITED STATES

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The following article is one of a series made possible by a grant from the Joint Research Committee of Claremont Colleges, Claremont, California.

In the December, 1941, and the February, 1942, numbers of *Science Education* an article by the writers discussed the condition of science sequence and enrollment in the secondary schools of the United States. As indicated by returns from the nationwide questionnaire sent out in 1941 to some 2200 schools in all parts of the country, usable replies were received from 655 schools representing every state in the Union. The following paper deals with science objectives, the methods used for achieving them, and the methods for evaluation used by science teachers as indicated by returns from the questionnaire mentioned above.

It might not be amiss at this point to review the methods of selection used in obtaining the list of schools. The nucleus of the group was a list of schools used in an original study made by the senior writer in 1909.[1] To this list of 500 schools was added in 1923 a second list of 500 representative high schools.[2] Again in 1930 when the original investigation was continued, 500 representative junior high schools were added making a total of 1500 schools.[3] The present questionnaire was based on this list plus about 250 junior high schools, a scattering of "progressive" schools and the secondary schools included in the Cooperative Study of Secondary School Standards,[4] a total of 2200 representative schools. The list of secondary schools used in the final schedule was taken from the Office of Education publication giving the accredited high schools of the United States.[5]

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[1] Hunter, George W., "The Methods, Content and Purpose of Biological Science in the Secondary Schools of the United States," SCHOOL SCIENCE AND MATHEMATICS; X; 1–10, 103–111, January, February, 1910.

[2] Hunter, George W., "The Place of Science in the Secondary School," *School Review*, 33: 370–381, 453–466; May, June, 1925.

[3] Hunter, George W., "The Sequence in the Junior-Senior High School," *Science Education*, 16: 103–115; December 1931.

[4] Evaluation of Secondary Schools, Cooperative Study of Secondary School Standards, Washington, D. C., 1939.

[5] Carr, M. J. G., Accredited Secondary Schools of the United States, United States Department of Interior, Office of Education, Bulletin 1938, No. 2.

Accompanying the questionnaire was a letter, which stated briefly the problems of which a solution was attempted through the agency of the questionnaire. This letter, an excerpt from which follows, was intended to arouse the interest and secure the cooperation of the teachers who answered the series of questions.

"During the past ten years many new problems have arisen to be faced by the teacher of science. The aspect of consumer education as opposed to that of training the producer; the change of emphasis from the propaedeutic function of science to that of preparation for one of more intelligent citizenship and useful social living; the introduction of the core curriculum and its effects on science teaching; the attempts of the so-called progressive group to correlate and integrate science materials with the social studies; the increasing emphasis on the method of reflective thinking in everyday life and the changing values sought for in the testing program, are all problems that demand the attention of the teacher of science. In view of all this it is felt worth while to continue the research, directing attention to the needs of today as well as adding information in order to make a comparative study based on all of the surveys."

The list of objectives given was formulated from several sources. As a background were the objectives coming from the teachers who had answered the 1930 questionnaire. This list was published in a paper which appeared in 1932.[6] It was a composite based on 1158 responses from teachers in the 517 schools that answered the 1930 questionnaire. A second source was the list of objectives given by the Committee on Secondary School Science of the National Association for Research in Science Teaching. This list was given in their report published in 1938.[7] Numerous other sources were drawn upon such as recent books on the teaching of science and articles in recent periodicals, and from these a composite list of objectives was prepared. Before placing this list in final form it was submitted for criticism to several teachers of science and professors of education. A final list of 30 science objectives appeared on the first sheet of the questionnaire in the form which follows.

Please evaluate the objectives below in the light of what actually happens in your school: not on what you believe should happen. Check as follows: Under 1 if it is a major objective in your school, under 2 if an important one, 3 if considered but not stressed, 4 if of no significance, and under x if not in agreement with the statement. You may add other objectives if you wish.

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[6] Hunter, George W., and Knapp, R. A., "Science Objectives at the Junior and Senior High School Levels," *Science Education*, October, 1932.

[7] Hunter, George W., Chairman, Report of Committee on Secondary School Science of the National Association for Research in Science Teaching, *Science Education*, October 1938.

Level	Objectives	1	2	3	4	x
	1. To foster appreciation for conservation of our natural resources.					
	2. To impart to the student the ability to behave intelligently as a consumer.					
	3. To make functional adjustment toward the more practical aspects of life.					
	4. To promote good citizenship by applying the knowledge of science to community life.					
	5. To help the student in the acquisition of worthwhile ideals and habits.					
	6. To promote a better understanding of personal health needs.					
	7. To attempt to train the student in the steps of the scientific method.					
	8. To train the student to withhold conclusions as tentative until facts are secured.					
	9. To impart to the student the ability to evaluate and interpret data.					
	10. To help the student to develop a fact finding technique.					
	11. To help to develop the power of observation.					
	12. To help to develop an attitude of freedom from dogma and superstition.					
	13. To emphasize the use of the control and experimental factor in experimentation.					
	14. To help students to formulate hypothesis.					
	15. To give students the generalizations of science found in the writings of specialists.					
	16. To guide students in the use of the facts of science in making their own generalizations.					
	17. To impart knowledge of the environment.					
	18. To develop a better understanding of the environment.					
	19. To develop an appreciation of our environment.					
	20. To give the student as much factual science material as possible.					
	21. To aid the student in acquiring information useful in solving life problems.					
	22. To offer exploratory experiences in new fields of interest.					
	23. To help to develop a worthy use of leisure time.					
	24. To help in election of later courses in science.					
	25. To prepare the student for college entrance.					
	26. To train students for certain scientific vocations.					
	27. To develop an appreciation for the work of scientists.					
	28. To help in formng habits of accuracy and neatness in all operations.					
	29. To foster democracy by using the classroom as a place to share experiences.					
	30. To help the student in the selection of worthwhile scientific reading.					

FIG. 1. Graph for Junior High School Showing Percentage of Teachers Giving Objective Major Emphasis.

The answers of teachers from the 655 schools responding to this part of the questionnaire were tabulated by the authors and charts and graphs made of the emphasis placed on each of the thirty objectives. The material was further broken down into objectives for junior and senior high schools, as it was obvious that differences in the approach of science at different age levels would naturally make for differences in objectives. In addition the answers were still further broken down into areas of the United States in order to see if there were differences in the attack of science problems in different parts of the country. Next a comparison was made with the emphasis given to objectives in the 1930 questionnaire by teachers, many of whom were in the identical schools that answered the 1941 questionnaire.

The two graphs show the percentage of teachers giving major emphasis for each of the thirty objectives. Figure 1 showing the junior high school level, and Figure 2 the senior high school level. It is interesting to note that the objective that ranks highest at the junior high school level is (18) "To develop a better understanding of the environment." Second and third in order at the junior high school level are: (17) "To impart knowledge of the environment" and (19) "To develop an appreciation of our environment." Fourth comes the important objective "To develop a better understanding of our health needs," while (11) "to help to develop the power of observation" comes in fifth place. At the senior high school level it is interesting to note the (18) "To develop a better understanding of the environment" stands at the head; but it obviously is not as important as at the junior high school level since it rates 58.6% against 75.4% at the junior high school level. The health objective (6) is rated second, while (7) "To attempt to train the student in the steps of the scientific method" comes third. In the fourth place comes (11) "To help to develop the power of observation," and in fifth place we find (19) "To help to develop an appreciation of our environment."

Careful study of the graphs show some interesting facts. The list of objectives as finally prepared by the writers was formulated so that among the objectives held high by educational circles there were interjected some less important. In one case an objective of a rather vague nature, (7), was broken down into a number of attitudes, skills, and appreciations in the hopes that the thoughtful teacher would seize upon the important factors in reflective thinking as goals in teaching. However, this did not

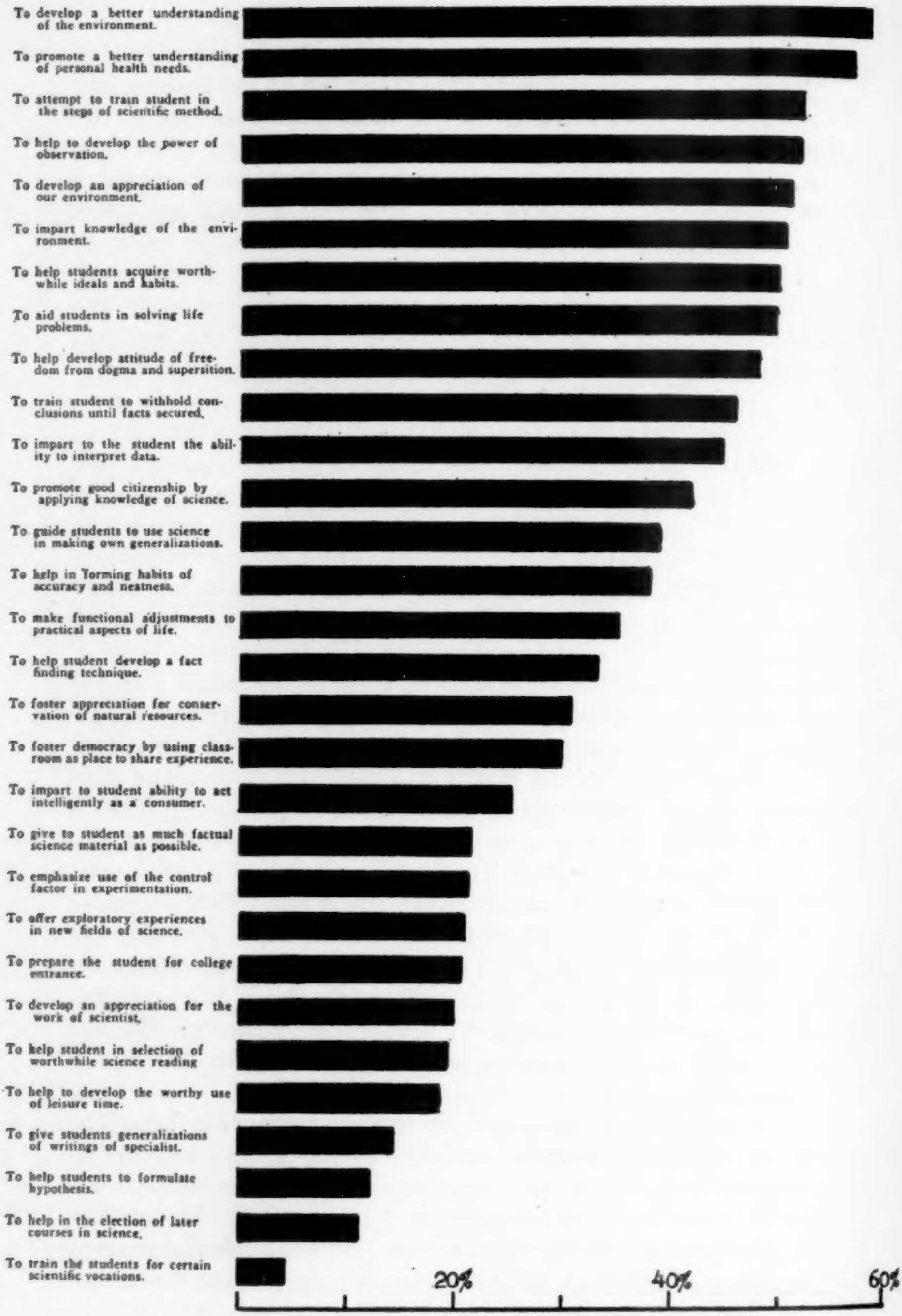

FIG. 2. Graph for Senior High School Showing Percentage of Teachers Giving Objective Major Emphasis.

happen, as judged by the answers given. It is evident from a comparison of the two graphs that much more emphasis is rightly placed on reflective thinking at the senior high school level than at the junior high school level. One rather interesting fact is the important place awarded to (11) "To help to develop the power of observation." This objective held fifth place at the junior high school, and fourth place at the senior high school level. Just what is meant by this is difficult to state, but the writers had placed this objective in the list as a "buffer," believing it to be a by-product rather than a real objective of science in the secondary school. Evidently the teachers consider it a very worth while objective.

Another surprise was the low place awarded consumer education. At the junior high school level this objective stood twenty-second out of a list of thirty, while at the senior high school level it was placed nineteenth on the list. When one considers the emphasis placed on this objective by leading educators today, it would seem that the rank and file of science teachers are not seriously considering this development in science education. Still another surprise is the low place awarded to conservation of natural resources as an objective in science teaching. This objective was awarded fifteenth place by the junior high school teachers, and seventeenth by the teachers of the senior high school level. One would expect greater emphasis at the higher age level.

It is evident that if we sum up the objectives that have to do with the attitudes and teachniques of the scientist as used in reflective thinking, numbers (7), (8), (9), (11), (12), (13), (14), (16), (21), and (28), taken together, they rank high in the present day practice of teachers of science. It will be noted that while they do not stand high individually, taken together they occupy a very important place, especially at the senior high school level. Such objectives are rated as much more important today than they were ten years ago according to statements of teachers in the 1941 questionnaire. It is interesting, however, to note that in 1930 the membership of the National Association of Research in Science Teaching largely supervisors, training teachers, and university professors rated these objectives much higher than did the teachers, thus showing that leadership in educational matters is slow in acceptance by the rank and file of the teaching profession.

One of the most striking differences in the list of objectives

as given in 1930 and 1941 is the place of preparation for college. In 1930 at the senior high school level the propaedeutic function stood first on the list of science objectives given by science teachers, and in the junior high school tenth on a list of 27 objectives mentioned by teachers. In 1941 it stood as twenty-third on a list at the senior high school level, and twenty-ninth on the list of the junior high school level. Evidently many of the state supported schools are saying to the colleges and universities "You must take our products as we prepare them for life for we are not interested in training for college examinations as such." While the private schools responding rate this objective high, certain larger public high schools in all parts of the country also give the preparation for college as one of the important objectives. For the most part, however, the secondary schools turn from teaching for college entrance to the objectives that deal with life realities and problems such as health needs, the acquisition of appreciation, ideals, and habits that are functioning in everyday life, and knowledge about and interpretation of the environment. One difference in the data given by the 1941 respondents would surely be noted if the same list of objectives were given today. Objective No. (26) "To train students for specific scientific vocations" is placed at the bottom of the list by both junior and senior high school teachers. With the present shift in training for the war effort it is highly probable that this objective would rate much higher today, as pointed out by the recent report of The Cooperative Committee on Science Education.[8]

Separation of objectives into the areas previously referred to as given in the earlier paper reveal some interesting data. The New England States come highest in the preparation of students for college entrance. This we should naturally expect, but we would not expect to have them rate the objective No. (23) "To help to develop a worthy use of leisure time" as high as they do. This area also rates high training for specific vocations. The area rates lowest of all in consumer education, in conservation, and in developing a better understanding of the environment.

The Middle States rate second highest in the group in training for college entrance. They also rate higher than the other groups in "developing the power of observation." They are in the

[8] The Cooperative Committee on Science Teaching, "High School Science and Mathematics in Relation to The Manpower Problem," SCHOOL SCIENCE AND MATHEMATICS. February 1943.

middle of the road on the other objectives, excepting that of training for vocations, where they stand low.

The North Central States stand near the middle in almost all of the objectives except consumer education. This objective rates second highest in all the other geographic areas. This area rates lowest in the objective "To help to develop the power of observation."

The Rocky Mountain States, which include the states of the Great Plains as well, were near the top in "a better understanding of the environment," were second in "a better understanding of health needs," and were first in their rating of consumer education as important. Other objectives held a rather intermediate place.

The Southern States rated highest in health needs and conconservation and in preparation for vocation. They also rated high the objective "to develop the power of observation" and the one relating to the understanding of the environment.

Another part of the questionnaire was devoted to an attempt to discover the methodology used by teachers in obtaining their objective. For this purpose the tabulated form on the following page was used.

This form was used as a comparison with a somewhat similar outline used in the 1930 questionnaire. The findings from this questionnaire were published in 1933 in a paper[9] which appeared in the March 1933 number of *Science Education*. In this questionnaire the following methods were noted: "Textbook; reference reading; laboratory; demonstration; discussion; field work; projects; and others." It will be noted that in the present questionnaire these methods were broken down into eleven headings instead of eight. Because of the laboratory-demonstration controversy, the question was made more exclusive so as to include teacher and pupil demonstration. Because of the present greater emphasis on visual aids this category was included. Also the workbook idea had developed since the 1930 questionnaire so that was included as a method. Then because of the present emphasis on individual differences a category entitled "individual instruction" was also included. The following table is based on nation-wide statistics taken from 655 schools.

The picture in general as compared with that of the 1930 findings has not greatly changed. As has been pointed out the

[9] Hunter, G. W., and Edinger, O. H., "Methodology in Science," *Science Education*, March 1933.

For each subject given in your science department indicate by numerals from 1 to 11 the relative emphasis placed on different methods used. That is, if you use all of the ones listed below, place a 1 under the method used the most frequently, a 2 under the one used second most frequently, etc.

	Discussion	Demonstration (Pupil)	Demonstration (Teacher)	Field Work and Excursions	Individual Laboratory Work	Individual Instruction	Projects	References and Reports	Text-Book	Visual Aids	Work Books	Write in any other Methods that You Use
Agriculture												
Biology (Advanced)												
Biology (Elementary)												
Botany												
Chemistry												
General Science												
Hygiene												
Physics												
Physiology (Human)												
Physiography												
Zoology												

1941 teachers were given a wider selection of methods over which to spread their ratings; this greater spread would naturally make for an average lower rating in comparison with that of the 1930 questionnaire. Even with this wider distribution of categories in the 1941 questionnaire we find the discussion method was still given the highest ranking in all of the sciences. This is in general agreement with the findings of the 1930 study.

Some rather interesting and significant changes of methods are shown in the 1941 findings when compared with the 1930 findings. In the first place individual laboratory work has suffered a drop in all of the sciences except physics where it holds the same relative position. To offset this the picture has changed in reference to the demonstration method, a growth being indicated in the use of the demonstration method in the ten-year period. In view of the many papers devoted to the laboratory-

TABLE 1. Average ratings and rank given to methods used in the teaching of science as expressed by the junior and senior high school teachers answering the questionnaire.

	General Science			Biology			Chemistry			Physics			Summary	
	1941		1930	1941		1930	1941		1930	1941		1930	1941	
	Rating	Rank	Rank	Rating	Rank	Rank	Rating	Rank	Rank	Rating	Rank	Rank	Rating	Rank
Discussion	1.96	1	1	1.91	1	1	2.09	1	2	1.94	1	1	1.97	1
Demonstration (Pupil)	5.28	6		6.59	9		5.94	6		5.64	7		5.86	7
Demonstration (Teacher)	2.28	2	2	3.78	2	5	3.83	3	3	3.59	3	4	3.52	2
Field Work and Excursions	8.08	11	7	7.93	11	7	8.60	11	7	8.50	11	7	8.28	11
Individual Laboratory	6.83	10	5	4.07	3	2	2.65	2	1	3.12	2	2	4.17	4
Individual Instruction	6.64	9		7.03	10		6.20	8		5.46	5		6.44	9
Projects	5.77	7	6	5.82	7	6	7.45	10	6	7.26	10	6	6.57	10
References and Reports	5.23	5	4	5.61	6	4	6.07	7	5	6.40	9	5	5.83	6
Textbook	3.44	3	3	5.25	5	3	4.28	4	4	3.64	4	3	4.15	3
Visual Aids	5.15	4		5.83	8		6.60	9		6.06	8		5.91	8
Work Books	6.35	8		5.19	4		4.86	5		5.50	6		5.47	5

demonstration controversy and the decision that both methods had their places in science teaching these findings are to be expected. The demonstration and particularly pupil demonstration has apparently established its value in general science and physics.

As we would expect visual aids are given a prominent place in the 1941 ratings with their greatest emphasis in general science. Since this was a new category in the 1941 questionnaire it is difficult to know just how much emphasis was placed upon the usage of this method in 1930, as it was included under the category "other methods." But their use has undoubtedly increased.

Projects are apparently losing some ground, particularly at the senior high school level. The excursion method is also losing ground, possibly because of curtailment by school authorities and partly, perhaps, because of actions brought by parents against school boards for injuries, fancied or otherwise.

The textbook has not lost as much ground as might have been expected because of the wider use of the library method since 1941. Workbooks are apparently given quite wide usage but opinion is divided as to their value. Examination of answers by respondents show that they were rated either very high or quite low. Apparently they have their widest usage in biology.

The new category of individual instruction made its best showing in physics. This would not indicate a wide use of individual instruction but considering the size of classes and the number of students per teacher in our present day high school the writers believe that the results of the questionnaire indicate that the teachers in our science classrooms are making an attempt to meet the needs of the individual student.

We have noted an increase in individual instruction, demonstration, visual aids, and workbook methodology, so naturally less emphasis would have to be placed upon some other techniques in order to allow for the growth and place awarded to the methods just mentioned. These findings are born out in a general way for the state of Minnesota as indicated by a recent paper by Hilgar.[10]

The last part of the questionnaire was devoted to the matter of evaluation. For this purpose a rather full and very carefully planned tabular question was used as shown by the following.

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[10] Hilgar, R. J., "Practices and Techniques in Science Teaching," *Science Education*, January 1942.

Kindly evaluate this material in the light of the subject you teach. Do not mark what you think ought to be done but what is actually done at the time of receiving this. Check as follows: 1 if it is a major method of testing a particular subject, 2 if an important one, 3 if used only rarely, 4 if not used at all. You may add other methods if you wish.

Level	Methods of Evaluating Learning Process	General Science	Biology	Chemistry	Physics	Survey Science	Write in
	1. Pre-test as a device for diagnosing pupils previous knowledge.						
	2. Use of exact methods of measurement.						
	(a) True and false (factual or problem, underline)						
	(b) Short answer (factual or problem, underline)						
	(c) Multiple choice (factual or problem, underline)						
	(d) Matching types (factual)						
	(e) Word definitions (factual)						
	3. Anecdotal record technique to determine growth in scientific thinking.						
	4. Use of standardized factual tests.						
	5. Testing for ability to apply scientific principles to new situations by use of the essay types of examinations.						
	6. Measuring and interpreting data by a 5 point response type test. (True, probably true, insufficient evidence, probably false, false).						
	7. Tests to reveal progress in use of laboratory techniques and skills.						
	8. Testing for factual knowledge only, without its application to problem solving.						
	9. Oral testing of problematic situations through discussion.						
	10. Testing to apply principles of logical reasoning.						
	11. Factual testing for college entrance.						
	12. Use of achievement tests as prediction of success in science.						
	13. Use of tests to evaluate sources of information.						

The "short answer" method of testing has the highest rating in all the sciences, with "oral questioning" second and "multiple choice" third. The definition type test tied for third place in life science, but from this point on there is a scattering of testing methods differing with the sciences.

There is very little emphasis placed on the pre-test, according to the answers received. Whether this means that the Morrisonian technique is being largely given up or whether it indicates a

modification of this technique, in which the pre-test is given orally, is difficult to say. Apparently the unit idea has come to stay.

TABLE 2. Average ratings and final rank given to methods of evaluating learning process by junior and senior high school teachers answering the questionnaire.

	General Science		Life Science		Chemistry		Physics	
	Rating	Rank	Rating	Rank	Rating	Rank	Rating	Rank
Pre-test	3.05	12	3.08	11.5	3.28	13	3.26	13
True and false	2.15	5	2.20	6	2.36	7	2.35	6
Short answer	1.64	1	1.63	1	1.57	1	1.78	1
Multiple choice	1.99	3	1.94	3.5	2.12	3	2.03	3
Matching	2.27	6	2.16	5	2.50	8	2.47	7
Definition	2.10	4	1.94	3.5	2.20	5	2.18	5
Anecdotal record	3.25	13	3.50	14	3.35	14	3.14	15
Standardized	3.02	11	2.83	10	2.22	6	2.60	10
Application by essay	2.67	10	2.66	9	2.54	9	2.49	8
Five point	3.72	17	3.52	15	3.55	16	3.62	17
Laboratory techniques	2.55	8	3.08	11.5	2.78	11.5	2.88	12
Factual knowledge (only)	2.64	9	2.60	8	2.60	10	2.53	9
Oral	1.85	2	1.86	2	1.95	2	1.90	2
Logical reasoning	2.29	7	2.30	7	2.18	4	2.14	4
College entrance	3.68	15	3.23	13	2.78	11.5	2.75	11
Achievement	3.53	14	3.54	16.5	3.40	15	3.40	14
Evaluate sources	3.65	16	3.54	16.5	3.58	17	3.60	16

In spite of first place being given to the "short answer" test, which must be factual by nature, the use of the factual test is disclaimed by many who answered the questionnaire. It is given ninth place in general science, eight place in life science, tenth place in chemistry, ninth place in physics, and tenth in science survey.

Standardized tests are not largely used to judge from the answers received. They occupy the eleventh place in general science, tenth in biology, tenth place in physics, sixth in chemistry, and twelfth in science survey.

College entrance tests have dropped greatly from their usage of ten years ago. While no figures in such tests are available from the 1930 questionnaire, yet the objectives of that period show the propaedeutive functions to be at the top at the senior high school level. But today, even in physics and chemistry,

typical college entrance subjects, the college entrance tests hold eleventh place.

The newer types of evaluation such as antedotal record, evaluation of sources, achievement, and the five-point rating scale for measuring and interpreting data are little used as judged by their place in the responses.

Can we draw any conclusions from this collection of data? The questionnaire specifically asked that the answers be given on the basis of what actually occurred in the schools where the teaching was done. Most of the questionnaires show that the respondents took this request seriously, especially where the questionnaire was passed from one teacher to another in the school. The questionnaires went to a highly selective number of schools. It was a formidable document. It was answered by relatively small but interested group of teachers. Therefore, we may safely assume that the answers really indicate the actual practices in teaching of science in this group of representative schools. It is obvious that the objectives which teachers rated highest in both junior and senior high schools are a better understanding and knowledge of the environment. Are the methods of teaching and testing used the best to accomplish these ends? Very high in the list of objectives for the senior high school were placed the several attitudes, ideals, and practices which together make up what we call the scientific method or what may be more properly spoken of as reflective thinking. Here again we may ask ourselves the question: Are the methods used, especially the testing techniques, those best adapted to bring about the desired results? The data presented from the questionnaire has been given without comment and without bias on the part of the writers. Thinking teachers who read these pages will find the answers in the evidence given.

A NEW STETHOSCOPE

Sounds within the human body are coupled more closely to the ears of the physician by an improved acoustic stethoscope. Much more sensitive in its range of hearing than an ordinary stethoscope, the new instrument is claimed to introduce significant sounds formerly heard weakly if at all. By turning a knob the physician can adjust the hearing range at will.

RESIN-TREATED CEMENT

Resin-treated portland cement, now used in road construction, resists winter deterioration due to freezing, thawing and applications of salt for ice removal. A special pine wood resin is used, one tablespoonful to each sack of cement.

NOTES FROM A MATHEMATICS CLASSROOM

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(*Continued from the June issue*)

54. Daily Reviews. The start of a new year is a good time to suggest a pedagogic device that I have found useful:

Begin each day's work with a short oral review.

The device is applicable whether the class is algebra or geometry, and whether it is twelfth, eleventh, tenth, or ninth grade work. And the device applies as well to the second day as to the twentieth. At first the questions may cover only the preceding day's work, such as:

What is a formula? Mention some that were studied yesterday. What good are formulas? What does the letter A remind you of? What comes to your mind when you see the expression lw?

In a geometry class a three-minute review might be:

What do you know about a point that is as far from one line as it is from another line? What do you know about the points on the bisector of an angle? What other theorem resembles the one we have just heard? What is a converse? If the motorman on a street car heard two pupils talking about parallel lines, what fact about such lines would occur to him?

When the questions involve the work of the previous weeks the pupil gets a broader view of the unit and he sees how the details fit into a larger structure.

Even on examination days, whether it is a thirty-minute examination or a ten-minute test, I take a few minutes for an oral review. Naturally I would not ask questions that hint at the examination, but I want to give the pupil a chance to readjust his mind, to forget Ohm's Law and the conjugation of *tener*. If the pupil has come to class breathless after a four-minute run through the corridors, he has time to relax, to throw out the Botany lesson from his mind and adjust it to a mathematical setting. I have no statistical evidence as proof but I believe that those few minutes of mental readjustment enable the pupil to do better work during the remainder of the period.

The books on pedagogy tell us that reviews have a dual function: the fixation and retention of facts, and the thoughtful organization of the details into a coherent whole. The daily oral

review kills both birds. Of course we would rather have the pupil do the shooting, but only the superior pupils can do this kind of shooting. Many textbooks do the organizing for the pupils by presenting a summary of the unit or by numerous tests of the "short answer" variety. I question the value of any summary unless the pupil actively participates in the making of it. At the end of a unit I assign this problem: Make a list of the questions I have asked oftenest in the daily reviews.

55. Geometry and Air-Navigation. At the start of a new school year we might also consider the question: Which concepts and theorems of geometry are most used in navigation problems? A few years ago Hale Pickett in a Columbia dissertation made an interesting study of examinations given by various Boards, and ranked the theorems of geometry according to the frequency with which they were needed. If it has not already been done, we need a similar study for the field of navigation. Last spring I taught a class in air navigation, and the following items rank high in frequency of use:

1. Interception problems involve the rule: *Constant bearing means collision,* meaning that if we want the moving objects to meet then the bearing of one from the other must be constant.

Geometrically this means: If a line crosses two sides of a triangle so that one side divided by one of its segments equals the other side divided by the corresponding segment, then that line is parallel to the third side of the triangle.

2. The resultant of two forces acting at a point A is the diagonal of the parallelogram whose sides represent, as vectors, the two forces.

The physicist refers to this statement as the *parallelogram of forces;* the aviator speaks of the *triangle of velocities.* Although problems deal ng with the wind, heading, and track can be solved by drawing only half of the parallelogram, I found that many questions (like "Does the heading vector always go from the wind to the track?") can be answered better if the entire parallelogram is shown. For this class, the only significant items about a parallelogram are that its opposite sides are equal and parallel.

3. If the wind vector, the direction of the track, and the airspeed are known, the heading is found by constructing a triangle whose known parts are two sides and the angle opposite one of those sides.

This construction is seldom used in plane geometry. In trigo-

nometry it is the ambiguous case. In navigation there is no ambiguity since only one triangle is consistent with the rest of the data in the problem.

4. When finding the bearing of B from A if the bearing of A from B is known, the useful facts are: Alternate interior angles of parallel lines are equal and the related theorems.

5. The locus of points equidistant from the ends of a segment is the perpendicular bisector of the segment. This theorem is used in dealing with a plane heading in one direction and then returning to a different field.

56. Anticipating Future Needs. We have heard a great deal, and may expect to here more, about revising geometry so that it will be a better preparation for the courses in navigation. I ask myself: What changes shall I make this year as a result of my experiences with the navigation class? I think now that the answer is: Practically none.

If it is necessary to create an interest in some topic or if some lazy pupil needs a push to make him work, I might some day discuss the nature of the problems in navigation and show how they depend on certain theorems. A good rigorous course in geometry is the best preparation for the course that depends on geometry.

The class spent about six weeks on Chapters 23, 24 and 25 of the *Elements of Aeronautics by Pope-Otis*. Typical problems are solved in the book, and after studying the example in the book the pupils could solve similar problems. But the questions that disturbed the class (and taxed all my ingenuity as a teacher) were: How did the authors find out how to solve the problems? We see that the method works, but who thought of it? How can we find a solution if the problem is different from the examples in the book? How were the solutions discovered? Is there some general method or principle which is the basis for the solutions, or must each example be memorized *as the book suggests?*

The boys were avid readers of aviation magazines. In *Current Aviation*, March 5, 1943, is a problem like one in the textbook, but solved in a different way. How do you prove that they are consistent? Finding the radius of action as explained on page 297 of the *Mathematics Teacher*, Nov. 1942, is not the only method. When different methods are presented, a great deal more geometry is involved than is suggested by section 55.

It is in such situations that the pupil (and teacher) realize the value of knowing more than those few theorems which rank

high in frequency. The best preparation for a course in navigation is a course in geometry in which the pupil is so busy working with geometric relations that he has no time to study the applications to navigation. Then in the navigation class he can devote his energies to navigation instead of studying the geometry that he should have learned in his geometry class.

57. Graphic Solutions of Problems. No curriculum revision is up-to-date unless it advocates more attention to using graphs in the solution of problems. See, for example, the 1940 *National Committee Report*, page 90, with reference to ninth grade work. An interesting program for a teacher's meeting can be fashioned around that topic. Which types of problems can profitably be studied graphically? And why?

In the chapter "How Algebra Began" in *Hogben's Mathematics for the Million* are eight problems illustrating the use of equations in solving problems. Graphs are not used. But one problem is of the type that is now frequently solved graphically in ninth grade texts. The problem is:

A train leaves London for Edinburgh at 1 o'clock, going 50 mph. Another train leaves Edinburgh for London at 4 o'clock going 25 mph. If Edinburgh is 400 mi. from London, when do the trains meet?

A ninth grader would derive: $50(3+t)+25t=400$.

A graphic solution would show one line starting at (0, 0) with a slope of 50, and another line starting at (3, 400) with a slope of -25. The lines intersect at $(6\frac{2}{3}, 316\frac{2}{3})$.

I have used a similar problem on many groups of third and fourth year pupils with a view to learning what method they use when they have several at their command. The more mathematics they have studied the more likely they are to work thus:

The London train has a three-hour start, covering 150 mi. in that time, leaving 250 mi. to be covered after 4 o'clock.

The trains approach each other at a rate of 75 mph.

Hence it takes $250 \div 75$ or $3\frac{1}{3}$ hours to meet.

In the ninth grade books this is the only type of time-rate-distance problem which can be solved graphically. And, for it, the arithmetic solution is by far the simplest. Evidently the pupil will not care for graphic solutions unless the problem is one in which the graph contributes something useful.

Duty and today are ours, results and futurity belong to God.

SOME PROPOSALS FOR A UNITED SCIENCE FRONT

The Central Association of Science and Mathematics Teachers has endeavored to be of assistance in every way possible in the study of plans and procedures for pre-induction education in its specialized areas. Thirty-eight Biology and Physics members, in cooperation with teachers from other organizations, are acting as field consultants for the Civilian Pre-Induction Training Branch of the Army. Professor Ira C. Davis of the University of Wisconsin is chairman of this cooperating panel from the Central Association. The following report by Dr. Philip Johnson summarizes an informal point of view developed at meetings held in Washington, D. C., during the past several months.

GEO. K. PETERSON

The war has focused attention on science teaching. Science teachers have been eager to modify instruction to meet the emergency. There have been differences of opinion as to the modifications which were needed, and as a result, there has been an undesirable amount of confusion and complacency. This condition is unfortunate and much of it has been the result of hearing and reading about segments of the science needs. Only recently have leaders in the various organizations of science teachers had the opportunity to see the entire area of needs and to assist in meeting these needs.

Several leaders from organizations involving biology teachers were called to Washington, D.C. in May for a meeting relating to health education. These persons returned for a work period in June. Similarly a group of leaders from among organizations of physical science teachers participated in a work period in Washington, D.C., during the third week of July. At each of these meetings plans for further cooperation were discussed with eagerness and concern. The leaders from among the five organizations involving biological science teachers prepared a series of proposals which they adopted as a statement of their ideas. The leaders from the organizations involving the physical science teachers studied these proposals and likewise adopted the state ments as an expression of their ideas. Thus, the statements given below have been adopted by leaders from among eight organizations of science teachers. This statement of proposals is being printed in all the magazines of these organizations and the judgments of all members are desired. Kindly communicate your ideas regarding these proposals and how they may be carried out to the executive officer of any one of the following organizations.

National Association of Biology Teachers
M. A. Russell, President
403 California Ave.
Royal Oak, Michigan

American Science Teachers Association
Morris Meister, President
184 Street and Creston Ave.
New York, New York

American Council of Science Teachers
Norman Jones, President
5073a Mardel (9)
St. Louis, Missouri

Duquesne University Conference for Teachers of Science in Catholic High Schools
Hugh C. Muldoon, President
Duquesne University
Pittsburgh, Pennsylvania

Central Association of Science and Mathematics Teachers
George K. Peterson, President
North High School
Sheboygan, Wisconsin

The American Nature Study Society
George J. Free, President
Pennsylvania State College
State College, Pennsylvania

The American Association of Physics Teachers
Lloyd W. Taylor, President
Oberlin, College
Oberlin, Ohio

The Division of Chemical Education, A.C.S.
B. S. Hopkins, Chairman
High School Chemistry Committee
University of Illinois
Urbana, Illinois

The Federation of Science Teachers of New York City
Maurice Ames, President
110 Livingston Street
Brooklyn, New York

Association of Science Teachers of the Middle States
Dr. Reuben Shaw
Chairman of Special Committee
Northeast High School
Philadelphia, Pennsylvania

National Association for Research in Science Teaching
Hanor A. Webb,
George Peabody College for Teachers
Nashville, Tennessee

National Council on Elementary Science
Florence Billig
Wayne University
Detroit, Michigan

Assumptions

I. "We have one great task before us. That is to win the war. At the same time it is perfectly clear that it will be futile to win the war unless during its winning we lay the foundation for the kind of peace and readjustment that will guarantee the preservation of those aspects of American life for which the war is fought."

In this statement to the Association of American Colleges, President Roosevelt defines the dual function of the Nation's efforts in the war, The implications for American education are clear.

The science teacher's responsibility in this dual role is exceptionally large. First he recognizes the importance of his field in the successful prosecution of this technological war, for he real-

izes that the training he provides in essential fields may ultimately play a large part in winning the war. Second the science teacher is increasingly accepting responsibility in helping to provide an informed public opinion on the problems leading up to the war and the task of advancing the causes of freedom and security in the post-war world.

II. The nature of the war emergency and the peace problems which we will face demands a rethinking and continuous evaluation of science teaching.This is a technological war. It is being fought in laboratories, on testing grounds, and production lines, as well as on fighting fronts. An early, successful, and conclusive termination of the war depends largely upon the extent to which specialized implements of war can be designed and produced by the allied nations and thrown into battle by trained allied manpower. From drafting boards to front line action, this war is being fought by specialists. The great majority of men inducted into the Army today are assigned to duties requiring specialized training. Practical and functional knowledges and skills in science are fundamental to this training, as they are in almost every essential service to the Nation at War.

The problem of the pre-induction training best designed to fit young men for armed duties is complex. The answers to the problem have been more or less obscure and in some instances ambiguous. They can never be final or clothed in ultimate detail. But clarification of the answer is possible and the need for it is urgent. It can finally be made only by the teachers on whose shoulders rest the responsibility for effective training.

Similarly the successful attack by science teaching on the many persistent personal problems faced by young people and the social problems amenable to scientific treatment depends upon the critical analysis and leadership given by science teachers. This analysis and leadership must immediately be increased.

Resolutions

I. The present problems of science teaching are sufficiently important and urgent to merit the concerted attention of all leaders among science teachers. The national, regional and metropolitan science teacher associations should, therefore, cooperate as fully as possible in attacks on wartime problems of science teaching. As an effective means of attack on these problems, it is recommended that a war time council be formed with representatives from all active organizations of science teachers.

II. Many, and sometimes contradictory, reports have been made on the needs of the armed forces for pre-induction training in the area of science. The representatives on the wartime council should cooperatively and critically explore the needs of the armed forces, and should prepare such reports and other materials as may be needed for the effective meeting of military manpower needs through pre-induction training.

III. Non-military wartime needs should be explored through contacts with governmental and civilian agencies. Proposals and other materials should be prepared to help in the meeting of these needs through science instruction.

IV. There are real dangers that purely wartime training needs may unnecessarily de-emphasize long range goals of science teaching. These goals should be analyzed realistically and with intellectual honesty so that science education may make its fullest contribution to the personal and social problems of our young people and of society. It is assumed that many areas to which science education can contribute with peculiar effectiveness have not been attacked by science teachers with sufficient directness. Among these are problems of health, conservation, accident prevention, production and distribution for the needs of a democratic people, support of research, consumer education, and cooperation with other cultural groups for world stability.

V. The problems of scope and sequence in science education and the problems of improving instruction through increasingly valid teaching technics are of special importance to science education in a nation at war. They should be evaluated as such. Once goals are validated, recommendations of time allotment, necessary material facilities, and sound teaching procedures may, and should be, prepared by the cooperating organizations.

VI. Industry and the armed forces have drained the schools of competent teaching personnel to the point that the schools now face a critical manpower problem. The problem of staffing our schools for sound science instruction should receive the immediate attention of science teachers. The problems of in-service education and conversion of teachers from other fields demands immediate analysis and action.

VII. The associations should investigate ways by which science teachers may be encouraged to remain at their posts rather than leaving for other service.

VIII. Upon the basis of the above considerations a wartime platform of science teaching should be developed, published,

and released to the educators of the country. This should be based upon careful analysis of all problems addressed but must be done expeditiously for effectiveness in offering leadership. It is recommended that such a publication be released to the schools not later than the fall of 1943.

THE CONTRIBUTION OF SCIENCE IN THE DEVELOPMENT OF ART

PART II

Lester B. Sands, Ed.D. and A. Reid Winsey, M.Sc.
DePauw University, Greencastle, Indiana

Editor's note. This is Part II of the second of a series to two articles concerning the contribution of mathematics and science in the development of art. The first article discussed the place of mathematics in art and appeared in the December, 1942, issue of School Science and Mathematics. Part I of the second article appeared in the May, 1943 issue. D. R.

In our article published in May we discussed, among other topics, the influences of the life sciences in the progress of art. These sciences are anatomy and physiology, zoology, botany, and agronomy. In this article we continue with the discussion by treating the influence of the non-life sciences. These fields of science are chemistry, geology, geography, physics and mechanics, and astronomy.

B. Non-Life Sciences

1. Chemistry. The field of chenistry is making surprising contributions to modern art. While great emphasis is being placed on the work of the chemist in his laboratory, the study of beauty and force in chemical reactions has given the modern artist inspirations for functional designs and colorful patterns. The crystallization of elements and compounds has offered the academician and the abstractionist a new plateau of activity in art.

The mysterious quests of the medieval alchemists were frequently the subject for the Dutch artist who pictured these investigators searching for the philosophers stone, the elixir of life and the transmutation of baser substances to gold. David Teniers the Younger depicts the disorderly laboratory of the alchemist with as much detailed realism as the modern artist brings to his study of chemical laboratories.

2. Geology. Geology has given innumerable subjects for art through the study of rocks and earth formations as found in

all areas of the world. The artist has always been fascinated by stratifications, deposits and their distortions, and he has used all natural phenomena as models. He has painted chalk cliffs, glaciated areas, canyons, mountains, buttes, deserts and hills under every form of light. One of the best illustrations that we can offer in the use of geology is the series of studies made of precious stones by Salvador Dali. He has become so enamored of the pure beauty to be found in a perfect jewel that he has bedecked his pictures with the various stones.

Steven F. Chadwick's "Placer Mining" and Thomas Hart Benton's mural called "Mining" are good examples of geological subject matter. A pictorial catalogue of geological elements are portrayed in a section of Diego Rivera's Mural on "Workers" in the Detroit Museum. Here he shows the origins of coal, sand and limestone and symbolizes the organizing ability of the white race by means of lime crystals.

The relationship of geology and anthropology are to be found in Charles W. Peale's painting, "Exhuming the First American Mastodon, in 1801." Peter Hurd's egg-tempera painting "Dry River" brings out the feeling of the dormant yet irresistible powers resident beneath the earth's surface. Dynamic, subsurface forces have warped the land into towering, eroded hills which completely dwarf man and his feeble efforts at living. In the same vein we find the water color by Dodd called "Copper Hill." These are several of thousands of pictures which have used the earth's structure and movements as subject matter for art.

3. Geography. All landscape artists desire to travel with suitcases and palettes to those areas of the globe which give them inspiration. Some journey to paint spectacular phenomena such as volcanoes around the Pacific, the geysers of the world, waterfalls, groaning glaciers, mountains, iridescent ice-bergs, storms at sea and awe-inspiring cliffs and canyons. Others seek out more pacific or tranquil scenes. They paint the quiet lagoons of Venice or the South seas; the fertile valleys of the Nile or extended farms of the midwest attract their brushes; deserts, plains, plateaus, farmlands and shaded woods furnish unlimited subject matter to the artist. While first hand experiences with these scenes is essential, yet for a full understanding of the forces basic to the phenomena, they apply to the geographer. The sincere artist stands in reverence above the lava beds then turns to the scientist and asks, "How came this miracle?"

A study of recognized art works which utilize geographical subject matter reveals that many phases of this science have been employed. For example, "Tornado Over Kansas" by John Stuart Curry depicts a man and his family fleeing before the destructive kinetic forces of a middle-western twister. The subject of weather and man's ignorance is again utilized in the painting by Alexander Hogue of "Drouth Striken Area." This study may be contrasted with that of Paul Sample's picture, "Janitor's Holiday" which depicts an ideal rural scene of farms and fertile fields. A section of the murals in the U. S. Treasury Building in Washington by Henry V. Poor is devoted to the surveying of new western lands. Frederick Judd Waugh has delighted nearly all marine lovers over the world with his dynamic seascapes.

In the area of illustrated maps, geography has offered subject matter which borders on the fine arts. A group of maps by Covarrubias serves to show the infinite possibilities of illustration in geography.

4. Physics and Mechanics. Almost every scientific discovery in physics and in the functional application of physical laws in mechanics has received some treatment by artist or illustrator. Innumerable examples may be shown relative to the discoveries of such men as Galileo, Copernicus, Boyle, Archimedes, Helmholtz, Franklin, and Edison. While it is impossible to bring a complete catalogue of such illustrations, we can show how the artist has been utilizing specific scientific laws in their relationship to man.

The school of impressionism has employed sunlight and light effects as artistic subject-matter in such painting as Monet's "Haystack" and Chardin's "Kitchen Maid Returning from Market." Each of these pictures was repeated four times with variation only in the light found at different hours of the day. The Impressionist has utilized the scientific information available from the field of optics for his effects. He uses prismatic analyses of sunlight and has abandoned the old chiaroscuro light theories.

Conclusive evidences of the combination between anatomy and mechanics is to be found in George B. Bridgman's[1] book, *The Human Machine.* He has shown by comparative sketches that the musculature of the human body is essentially the struc-

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[1] Bridgman, George B., *The Human Machine,* Bridgman Publishers Inc., At Pelham, N. Y., 1939.

ture of an efficient machine. He compares the function of the muscles and bones with that of levers, screws and inclined planes. This is an authoritative and popular work among present-day art students.

Many of the principles of physics have provoked artistic production. Brangwyn illustrates man's use of the inclined plane in his picture of stevedoes "Unloading Oranges." The problem of friction is beautifully illustrated in a number of his drawings and paintings of man at work overcoming resistances and gravitational forces. He shows men tugging at barges and women dragging heavy bundles of laundry. A human application of molecular motion in gases is available in Reginald Marsh's picture "The Air Hole" which shows a young lady's skirts at an unusual elevation due to an air jet proceeding from the sidewalk in front of a sideshow.

In utilizing physical principles in mechanics, we may find innumerable illustrations in art. Bridges and other spectacular constructions have always been popular subjects for paintings. Thomas Hart Benton's mural named "Building" depicts many mechanical principles such as the lever, the pulley and their applications in derricks and steam shovels.

The principles of work are brought into focus in Millet's "Couper" showing a man driving a hoop about a barrel. In Goya's etching "Birdmen" we have an early study of aerodynamics. Industrial scenes and machines have such interest for both artist and laymen that muralists and painters have devoted much of their effort to these subjects. Rivera's mural in the Detroit Museum dedicates its center panel to the processes involved in the manufacture of an automobile. Charles Sheeler gives us a very interesting and detailed description of an industrial scene in his picture, "City Interior." In a more radical mood, the prize winning painting by Peter Blume called "Parade" illustrates the molding force of machines in our modern world. He does this by showing that the sole product of a network of complex industrial plants is a clanking suit of armor sent on parade down the street.

5. Astronomy. Throughout the history of art we find only limited use of astronomy because of certain practical difficulties. Night painting is almost an impossibility while only a limited number of astronomical subjects seem practicable in the daytime. It is noteworthy to observe that the moon and other planets seen occasionally in the daytime have been seldom

portrayed. Lunar and solar eclipses with their terrifying impressions upon unenlightened peoples have received slight attention. While scenes under moonlight and starlight have been given some treatment, artists generally avoid night subjects. It is possible to believe that comets, constellations, planets, meteors and the milky way might offer considerable artistic stimulation. These celestial bodies have been utilized to some extent in religious, mythological and imaginative works.

In Vedder's painting, "The Fates Gathering the Stars," we see an application of mythological interpretation of astronomical subject matter. Tintoretto's picture, "The Origin of the Milky Way" is an unusual conception of the creation of the stars. The moon at night is a fascinating subject in Blacklock's "Moon Mystery" and in Albert P. Ryder's "Toilers of the Sea."

C. Conclusion

In this treatment of the relationship between science and art, we have attempted to show how the artist has used science both in subject matter and in artistic media. It is well to note at this point that we have largely avoided discussing the multitudinous scientific principles that have been utilized in specific paintings. In any single scientific area it is possible to find a multitude of principles that have found application in paintings. Also, a scientist in any general field can find relevant pictures for the walls of his classroom, office or laboratory. However, a careful analysis of the paintings related to any field would probably reveal large areas of the subject that have been unexplored by the artist. For example, in astronomy, such principles as gravitation, precession of the equinoxes and spectroscopic analysis could be used for subject matter. Also, the many mechanical instruments developed in any science could serve to inspire painters. As science extends its apparently unlimited horizons of knowledge in all directions, it exposes dynamic subject matter of inspirational quality to the artist. From this we may anticipate that the artist of the future will become far more sensitive to the offerings of science and will consciously and systematically investigate all areas with an intelligent and appreciative brush.

A solemn and religious regard to spiritual and eternal things is an indispensable element of all true greatness.—*Daniel Webster.*

SIGNIFICANT FIGURES IN TRIGONOMETRY

Cecil B. Read and E. B. Wedel
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Many trigonometry texts published within the last few years contain some discussion of the subject of approximate computation and significant figures. It would seem that recent emphasis upon this topic has resulted in the inclusion of at least a minimum of material. In general, there is agreement that in multiplication or division involving approximate numbers, one is not justified in retaining in the result more than the number of significant figures in the least accurate of the given data. (One needs to be careful at this point. The statement is that one is not justified in retaining *more* than the least number of significant digits; it does not state that one is in all cases justified in retaining this many digits. The rules may be adequate for most purposes, more definite statements are available if needed.)[1]

This argument as to figures to be retained raises a closely related question. What accuracy in angular measure corresponds to a specified number of significant figures in a number? Very closely related to this is the question: What accuracy may be expected from a four place, or from a five place table? Careful analysis of the questions will show that it is difficult to give an exact answer to these questions. The trigonometric functions are ratios which may be expressed to any desired degree of accuracy. that is, a four place table is a table of ratios correct to four significant figures, etc. How accurately an angle may be determined depends upon the particular function used as well as the size of the angle itself. To give an extreme illustration, for angles of less than one degree, inspection of a table will show that if the angle is to be determined from its cosine, values correct to five significant figures will not allow determination of the angle within a range of several minutes, while if the cotangent is known, two significant figures will usually determine the minutes, and three significant figures will certainly give this accuracy. This example, although of value in emphasizing that no simple rule covers all cases, is obviously one that would rarely be encountered. It would seem that the rules frequently encountered have been determined from inspection of the tables, rather than by rigorous proof, if indeed, such proof is wanted in an ele-

[1] Bakst, Aaron, *Approximate Computation*, Twelfth Yearbook, National Council of Teachers of Mathematics, Teachers College, Columbia University, 1937, pp. 57 and 62.

mentary course. It should be emphasized that a "four place table" should mean one with four significant figures, not four decimal places.

A general, or average, rule which can be used as a fair approximation for work throughout the range of the tables, seems to be that two significant figures correspond to angles correct to the nearest degree; three significant figures correspond to measurement of angles to $10'$; four significant figures correspond to the nearest $1'$; and five significant figures correspond to the nearest $0.1'$ (or to the nearest $5''$). As an example of the statement made in another manner, we may say that results obtained by use of a four place table would be accurate to four significant figures or to the nearest minute. That the rule is a general or average rule is illustrated by a table of natural sines. While four significant figures will in general determine the nearest minute, it will not always suffice (Arc sin $.9625 = 74° 15'$ or $74° 16'$).

These rules would seem to be of definite value—their proper use would avoid the unnecessary labor involved in using a table more accurate than is justified by the given data. Proper emphasis upon the nature of approximate computation would no doubt bring joy to science teachers, to say nothing of avoiding absurd results such as I once obtained when a boy in beginning trigonometry, having access to a transit and steel tape, carefully computed for me the height of the school flag pole. He used all of his knowledge of trigonometry, and proudly brought the result—carried out to twelve decimal places.

Unfortunately, even in those texts which clearly and carefully state rules for approximate computation, we find some woeful disregard of the same rules. It is usually not with respect to the accuracy obtainable from a specified table, but rather with respect to the results which can be justified on the basis of the given data. Occasionally the issue is carefully avoided by a statement that the given data are to be considered exact. If this is to be the case, one wonders why bother the student with a few pages of discussion of significant figures, if there is to be no further use of the material in the text. Again, one finds statements similar to the following: Results in this book are always given to five significant figures, even though this degree of accuracy is not always justified. If this accuracy is not justified, why not attempt to determine what accuracy is justified? The confusion existing in many recent texts is perhaps best illustrated by selecting several examples from current texts. (As a

matter of fact, the idea of this note developed from the fact that in making a collection of examples for class use, using texts which had been under consideration for adoption, the authors of the note were amazed by the wide discrepancy in the accuracy with which results are reported.) For simplicity, all angles are expressed in Greek letters, although this was not the usage in all texts. Texts are identified by letter only.

	Given data	Text Answer(s)	Text
1.	$a=5, c=6, \beta=60°$	$b=5.6$	*A*
2.	$a=5, b=12, \gamma=60°$	$c=10.4$	*B*
3.	$a=3, b=2, \gamma=60°$	$c=2.646$	*B*
4.	$b=4, c=3, \alpha=45°$	$a=2.834$	*C*
5.	$a=26, b=35, \gamma=46°$	$c=25$	*D*
6.	$a=25, b=30, \gamma=50°$	$c=23.7$	*A*
7.	$a=4, b=7, \gamma=105°$	$c=8.9154$	*E*
8.	$b=5, \alpha=75°, \beta=30°$	$a=c=9.659$	*B*
9.	$c=15, \alpha=26°, \gamma=150°$	$a=13.2, b=2.09$	*B*
10.	$\alpha=95°40', \gamma=45°20', a=8.2$	$b=5.2, c=5.9$	*A*
11.	$\alpha=81°, \gamma=69°, a=30$	$b=15.187, c=28.356$	*C*
12.	$\beta=28°8', \alpha=19°41', a=5.37$	$b=7.5175, c=11.814$	*B*
13.	$b=0.1792, \alpha=30°14', \beta=89°58'$	$a=0.09024, c=0.1549$	*D*
14.	$\beta=35.20.5', \gamma=25°, a=55072$	$b=36659, c=26783$	*F*
15.	$a=17, b=12, \gamma=59°17'$	$\alpha=77°12'53'', \beta=43°30'7'', c=14.987$	*G*
16.	$b=232.23, c=195.59, \alpha=61°30'0''$	$\beta=67°37'44'', \gamma=51°9'16'', a=220.10$	*G*
17.	$a=26, b=35, \gamma=46°$	$\alpha=48°, \beta=86°, c=25$	*C*
18.	$b=30, c=25, \alpha=50°$	$\beta=76°2', \gamma=53°58', a=23.7$	*B*

Obviously the list could be continued at length. Comment may be unnecessary; however, a few points are worthy of consideration. Only one of the first seven problems rounds off answers to the degree of accuracy justified by the given data (assuming the rule stated previously, upon which there seems to be essential agreement). With sides given to one figure, and angles to degrees, one apparently may obtain a missing side to one, two, three, four, or five significant figures, depending upon the text—or, apparently upon the whim of the author, as is noted in problems 2 and 3.

One might compare problems 15 and 16—apparently one may obtain answers to five significant figures and to the second of angular measure, irrespective of whether given sides were accurate to two or to five significant figures. In problem 10, accuracy to minutes and two significant figures seems to produce answers to two significant figures; in problem 11 the same accuracy in given data apparently produces accuracy to five significant figures.

Certainly this topic of approximate computation and significant figures would seem to warrant proper treatment in the classroom. Many authorities think it good teaching practice to encourage students to consult other texts and references. It might seem that in this situation one would need to proceed with caution before sending a student to another text. Even if the author states that his data are to be considered exact, this statement may not appear in the section consulted by the student. In any event, if 23 is to be considered an exact number in a problem calling for five place tables, is there any reason for not writing it 23.000, or for not writing 46°00′00″? In this period in which great stress is being placed upon applications of mathematics, perhaps it is the duty of teachers to point out the limits of accuracy, not only of the tables being used, but also of results obtained with certain data.

A HOME-MADE CLINOMETER

Edwin E. Jacobs
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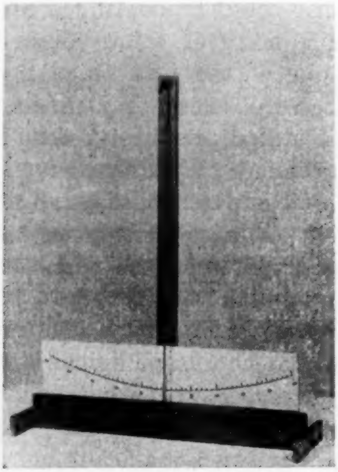
The accompanying cut shows a simple home-made clinometer. It consists of an upright some 16 inches long set at right



angles to a base 12 inches in length, from which a plumb bob is suspended. The small end pieces are so attached that the upright

can be adjusted so that the plumb bob will not rub on the scale of degrees.

Now, the degree of dip in tilted strata is reckoned on a line at right angles to the strike, assuming that the strata are not warped. If the line is drawn at any other angle, the degree of dip will be smaller than the true value, decreasing as one approaches the strike where the value is zero.

The various positions and the corresponding degrees may be demonstrated by setting the clinometer on a table, on end of which has been raised. When the base of the clinometer is at right angles to the strike (the end of the table, for example) the proper degree of dip will be recorded. When it is parallel with the strike, no degree of tilting will be shown.

Moreover, several problems in solving the right triangle may be set up with this clinometer, a yardstick and a magnetic compass.

HIGH SCHOOL PHYSICS

M. W. Welch

W. M. Welch Manufacturing Company, Chicago, Ill.

[The following letter written by Mr. Welch to Rev. Richard D. Spohn of Alma, California, expresses an idea worthy of thought by all interested in the high school program—Ed.]

It was a pleasure to read your article in the June issue of "School Science and Mathematics." Without putting it in so many words you have attached the basic philosophy of the curriculum makers in the United States. The high school physics laboratory, or for that matter any high school science laboratory, is not the place to introduce pupils to physics or an "appreciation" of physics. It is the place to introduce the pupils to scientific methods both of procedure and thought.

Professor N. Henry Black of Harvard pointed out to me, when I had the privilege of visiting him at Cambridge, England, the marked difference between the methods used in the preparatory school laboratories in England and in the United States. He had studied many of these schools and I verified it in a few. Here some fifteen or twenty experiments were considered the maximum but the methods were superlative and one got the distinct impression that the youngsters brought to their work an enthusiasm and something of a reverence for precise laboratory methods.

It has seemed to me that the curriculum makers in the United States should make up their minds in regard to what is wanted in the various fields of science on the high school level. If it is an introduction to the scientific method, then the laboratory should be used and well used. If it is only an appreciation of what the subject deals with, then the laboratory should be abandoned and the textbook should be a history and development of the subject. There should be supplemental reading, motion pictures, and all of the visual aids of charts and lantern slides, with special emphasis on the instructors' lecture demonstrations.

If it is both, then more time must be given to the subject. A smattering of both, which is so frequently attempted, seldom accomplishes either purpose.

It has seemed to me that the alarming and regrettable falling off of enrollments in the very important subject of physics, in the last decade or more can be largely attributed to the failure of leadership among the curriculum makers and this constant vacillation on the question of what is wanted on the high school level in the study of science. Fortunately at present the armed services have told us, in no uncertain terms, that they want sound laboratory teaching. To some extent industry in general has told us exactly the same thing.

EDUCATION IN ENGLAND

Herbert Morrison, England's No. 2 statesman, proposed equal educational opportunities for all English children. He took a whack at the "old school tie" and said:

"Personally, I hope that we shall be able to move toward a state of affairs in which the basis of our whole system will be a common primary school education for all, as it is in so many other highly developed countries. I think that it is not any solution of the secondary schools problem to send a few more poor boys to the rich man's schools.

"I think that it is the right policy for primary education to send many more rich men's sons to the poor man's schools—and to make those schools good enough for the sons of policemen and plutocrats alike. There could not be any greater step toward the real democratization of our society than to introduce a universal system of public primary education."

LIGHTER PLANES

Laminated sheets of phenolic plastic reinforced with aluminum alloy strips are now used as a new type of flooring in gigantic warplanes and plans are under way for installation on post-war passenger planes. Over 400 pounds of weight is thereby saved in a single 50-ton flying boat.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

ONE HUNDRED FIFTY-FIFTH MEETING
ANNUAL MEETING

Franklin Technical Institute, 41 Berkeley Street, Boston, Massachusetts
Saturday, May 22, 1943

9:45 Address of Welcome
Brackett K. Thorogood, Director of Franklin Technical Institute.

10:00 Business Meeting. Report of Nominating Committee and Election of Officers.

10:10 "A Stimulant for Physics Classes—Extracts from the Daily Press"
Lawrence A. Howard, Instructor in Physics, East Boston High School.

10:50 "Practical Use of Kodachrome Film."
Lecture Demonstration by Dr. Ralph B. DeLano, Memorial High School, Roxbury, Mass.

11:30 "War Courses, this Year and Next."
Discussion Group led by Robert W. Perry, Malden High School, Homer W. LeSourd, Milton Academy, and George H. Blackwell, Groton School.

12:20 Luncheon.

1:30 "Hobbies in Science."
Horace Taylor, A.M., Lecturer.

2:15 "Stereoscopic Views of Aerial Photographs." Explanation and Exhibition.
Melvin Barnes and Richard Logan, Instructors at Franklin Technical Institute.

It was originally planned to hold the last meeting of the season at a point distant from Boston, so that the meetings would be more evenly distributed in relation to different region centers of our membership population. The Association regrets that transportation difficulties have made it necessary temporarily to modify this policy somewhat.

Officers:

President: Clarence W. Lombard, High School, Hyde Park, Mass.
Secretary: Carl W. Staples, High School, Chelsea, Mass.
Treasurer: Albert R. Clish, Belmont High School, Belmont, Mass.

Executive Committee:

Hollis D. Hatch, English High School, Boston, Mass.
Charles S. Lewis, Brighton High School, Brighton, Mass.
Louis R. Welch, Dorchester High School for Boys, Dorchester, Mass.

BUSINESS MEETING

Report of the Nominating Committee

For President—Louis R. Welch, English High School, Boston, Mass.
For Vice-President—George H. Blackwell, Groton School, Groton, Mass.
For Secretary—Carl W. Staples, Chelsea High School, Chelsea, Mass.
For Treasurer—Albert R. Clish, Belmont High School, Belmont, Mass.
For Executive Committee—
Hollis D. Hatch, English High School, Boston, Mass.
Clarence W. Lombard, High School, Hyde Park, Mass.

Carroll H. Lowe, Brookline High School, Brookline, Mass.

RALPH H. HOUSER
JOHN P. BRENNAN
GEORGE W. SEABURG

The above were elected for the ensuing year.

A STIMULANT FOR PHYSICS CLASSES—AN EXTRACT FROM THE DAILY PRESS

(*Notes from an illustrated talk by* LAWRENCE A. HOWARD)

In trying to teach physics to all sorts of pupils, any device which will stimulate the lazy and indifferent will be welcomed by almost any teacher of the subject. As a rule, discoveries in science, inventions, and reports of scientific meetings have been culled from the newspapers and introduced in the class as current science. This practice is desirable, without doubt, but for the pupil it is merely an interpolation or, at most, a supplement to the textbook material. Other features of the newspaper—ordinary news items, sports pages, even the "funnies"—yield a surprisingly large amount of useful physics if one takes the trouble to look for it and read it in when necessary. Interest is not dependent on the rarely discovered desire to learn more, but, quite the reverse, these clippings actually can be made to create that desire to an extent which depends upon the ingenuity of the teacher in presenting and developing them.

The ease with which pupil interest can be captured and held is due to several factors. In the case of news items, the reality of the thing is appealing. These are not hypothetical situations created by the author of a text book, but are actual occurrences in daily life wherein the participants were real people whose names, addresses, and ages are given. It is possible that they may even be neighbors. In the reports of mishaps and accidents, it may be only a sensational appeal that holds the interest long enough to make the clipping serve its purpose in education. Surprise and pleasure are registered by students when they find that material for one of their school subjects can actually be found in the only parts of the newspaper which they read, the sports and the "funnies." There is engendered a feeling of friendship for the subject, a feeling which will not disappear with the next problem assignment if that problem is related, even remotely, to the clippings. Finally, there is the humorous appeal, definitely present, as in cartoons and comic strips, or worked up incidentally by the teacher in his handling of the item.

It is to be remembered that the use of newspaper articles is not for the purpose of entertainment, but to render the teachering job more effective. It is quite easy to group clippings for special duties, such as the following:

(1) To introduce a topic, the idea being to create an interest and to arouse a desire to know more about it.

(2) To demonstrate that the principles of physics do affect everyday life.

(3) To show the danger of ignorance of physical laws.

(4) To give the student practice in using his knowledge by handing him, without comment, an item to be critically read and evaluated.

(5) To give the pupil a feeling of superiority and satisfaction in his knowledge.

Mr. Howard brought clippings illustrating each of the classifications mentioned and indicated briefly how each could be treated in the classroom. An example of each group follows.

(1) A report of an automobile accident stated that a person was *thrown* through the windshield when the car hit a tree. This initiates a discussion of inertia.

(2) An account, with accompanying photograph, detailing the destruction wrought by static electricity in a rubber goods plant.

(3) A fatal accident occurred during an attempt to straighten an automobile drive shaft, which was hollow, but tightly closed at each end. A tremendous explosion occurred after the shaft had been placed in the fire of a forge.

(4) A press dispatch stated that an attempt was made to ascertain the depth of a certain spring by lowering an anvil into it. The attempt was a failure, however, because at a depth of some hundreds of feet, the upward pressure of the water was great enough to keep the anvil from going lower.

(5) Any cartoon, joke, or article of a humorous nature which portrays some individual's ignorance of the principles or the terminology of physics.

The dates of clippings need not be mentioned and they may be kept to present to the class at appropriate times. They may be used year after year unless a more recent and equally suitable one appears.

One of the interesting and valuable results of the extensive use of the newspaper is that as soon as the pupils get the idea of the thing they begin to supply the clippings themselves.

THE PRACTICAL USE OF KODACHROME FILM

Dr. Ralph B. DeLano, *Memorial High School, Boston, Massachusetts*

As science teachers we have been criticized for the poor quality of illustrative material we have used in books, magazine articles, and classrooms. It is the purpose of this short discussion to supply a few simple suggestions which may help to improve the quality of this type of visual aid.

A camera consists of a tight box with a single opening through which light may enter. In this opening we usually place a lens. The shutter is like a little sliding door which opens to admit light when we wish to take a picture. The shutter may be before the lens, between different sections of the lens, or behind the lens. In some cases it is placed near the film and is called a focal plane shutter.

Three letters, *T*, *B*, and *I*, may be found on inexpensive cameras. *T* indi-

cates the adjustment used for a long time exposure, *B* for a short time exposure, and *I* for snap shots.

Three series of numbers will be found on more expensive cameras. One set of numbers is used for focusing, another indicates the automatic shutter speeds, and a third shows the stop or diaphragm numbers.

Automatic shutter speeds on modern cameras often vary from one second to 1/1000 second. The stop, or diaphragm, controls the area of the light beam which enters the camera. Stop numbers on modern cameras may vary from 1.5 to 64. The smallest number represents the largest opening and the large numbers indicate the small openings. In the "*f*" system the stop numbers show the relation existing between the focal length of the lens and the diameter of the stop opening.

The "U.S." or uniform system of stop numbers is decreasing in popularity. Few new cameras are now marked with this system. These numbers may run from one to several hundred. The smaller numbers indicate the larger stop openings. Exposures in the "*f*" system are proportional to the squares of the stop numbers while exposures in the "U.S." system are proportional to the numbers themselves.

A small, pocket camera of the 35 mm. type is usually considered preferable for Kodachrome work. Because of the narrow latitude of this type of film, an exposure meter is almost a necessity. A haze filter makes a desirable addition to the above equipment. A wide-angle lens will increase the angle of view and a telephoto lens may be used in photographing distant objects.

Some amateur photographers think that if they record a natural scene the resulting picture will be properly composed because it shows things as they actually exist. It is true that we are sometimes fascinated by the natural beauty of a woodland scene or the glory of a sunset across a lake. Even in a case like this, however, there is always some one spot from which the best picture may be taken.

Every picture should form a harmonious whole. It would be incongruous to photograph a graduating class with a garbage truck in the foreground. Back of every picture there should be some central idea or concept. If the work is well done, the observer may gain this fundamental concept by looking at the picture.

Record pictures generally have poor composition. If we look at a photograph of two ships docked close together, we hardly know just why the picture was taken because we cannot decide upon the center of interest. Such a picture can be broken up into several different pictures. Let us select the great ventilating tubes as our center of interest. We now have a striking picture composed of vertical lines and ellipses.

The golden oblong, which is a rectangle with one side 1.6 times as long as the other, makes an excellent frame for a picture. In such a picture the center of interest is frequently located where a perpendicular dropped from a corner meets the diagonal.

Pictures should be balanced in much the same manner as weights are

balanced in the physical laboratory. A large object at a small distance balances a small object at a great distance. This often causes one part of the picture to appear to come forward while another part seems to recede.

Good pictures possess logical sequence. As we look at the smoke issuing from the top of great twin smokestacks, we are attracted by the shaded gradations in the smoke itself. Later we note Hogarth's line of beauty as the particles fade into the blue atmosphere. Our eyes now follow down the dignified, vertical lines of the massive chimneys and, although it is not shown, we realize that there must be a great power plant beneath them.

Contrast in pictures may be secured by placing highlight and shadow in juxtaposition, and a center of interest can be obtained by highly accenting a single object.

Pictures should be composed so that the eye of the observer will not enter at a corner or near the middle of a boundary line. It is considered good form to provide an inconspicuous exit.

Most pictures are composed in accordance with some fundamental form or type of composition. The triangle, the circle, and the cross are forms which are in common use.

The tranquillity, rest, and repose expressed by parallel lines are suggested as we see a tramp steamer heading for the Cape Cod Canal. Smoke from her funnels, which drifts away to form a long line on the horizon, is clearly visible from our ship. Through the haze we see the purple of the distant shore line. Above this, and parallel with it, the dim horizon line stretches across the picture. A few cloud streamers point toward the setting sun which gives a red tint to the whole scene. Since the light from the sun strikes the water at the proper angle, we see a band of light stretching from our feet toward the sun. The joining of this band with the distant parallel lines suggests the fundamental composition of the cross. A smooth, oily wave breaks the expanse of water in the foreground.

Diagonals and curves add much to pictures. Angles are harsh and often produce striking effects. It is considered bad form to have either a vertical or a horizontal line divide the picture into two equal parts.

Since a Claude Lorraine glass gives an erect image which is reduced in size, it is frequently used by photographers and artists in composing their pictures.

Portraits are difficult because they should have an inconspicuous background. If there are several people in a picture, one person should be so acting as to attract the attention of the others. This avoids divided interest.

Directions issued to beginners often state that the sun should be behind the photographer. However, interesting pictures can be taken with the sun directly in front of the photographer if the lens is shaded by holding the camera in the shadow of a tree or building. The lens may also be shaded with a hat or the hand.

Long shadows which extend toward the photographer require depth of field. This may be secured by the use of a small stop opening since the

narrow cone of light will produce smaller circles of confusion over a wider range. For practical purposes it is safe to say that one should use the smallest stop opening which will admit enough light to produce a picture.

The range of Kodachrome film is so narrow that it is an excellent medium for recording shadows. This narrow latitude, however, becomes a disadvantage when an attempt is made to photograph an object which has a wide range of light intensity. The illumination is so intense in tropical skies that the amateur photographer may find that his clouds have faded from the picture when he exposes according to the light which reaches him from nearby objects.

Although it is possible for a picture to contain only a limited amount of material, the fact should be kept in mind that a well composed photograph will suggest to the observer a vague and indefinite field which stretches forth to the uttermost limits of his imagination and experience.

If our educational systems are such that we cannot take our classes to the scene of action, we can at least attempt to bring real life situations to them by means of the camera. The day is not far distant when nearly all educational institutions which specialize in the training of teachers will have at least one required course in photography.

(70 Kodachrome slides were used to illustrate this lecture. Ranging from New Hampshire to South America they showed the possibilities of Kodachrome in all seasons, and in a wide variety of climates.)

WAR COURSES, THIS YEAR AND NEXT

Introduction: Robert W. Perry.

The keynote of this discussion will be,—What are we actually doing with war courses in our schools this year, and what are we definitely planning to do next year?

A year ago we were beginning to think about what courses we would add to the curriculums of our schools for the purpose of helping the boys who would soon be entering the armed services of the country. The Army and Navy and the office of the United States Commissioner of Education have suggested several subjects, many of which pertain largely to physics. This is one group of teachers that does not need much urging to endorse a program which emphasizes the teaching of more physics. However, there are many administrative problems involved in the matter of introducing new subjects into the curriculum, as most of us have found out. Therefore, I believe we are most interested right now in an interchange of reports on the war courses we have actually introduced.

Malden High School: Robert W. Perry.

This year we started with 30 Senior Scientifics in a class in aeronautics, 90 Senior Generals in three classes in radio, and 25 Junior Scientifics in a

class in meteorology. Although these classes were new and rather quickly formed, we believe that the work has been successful.

In planning for next year we have been guided by a policy of making a distinction between what we should try to do for the boys who are officer material and the others. By officer material we mean the boys who may become aviation cadets or who may be admitted to programs such as the V-12. These boys are to be found in our College Prep and Scientific Courses simply because it is in these courses that they study the subjects which prepare them for the above-mentioned programs. It is our understanding that the Army and Navy do not wish us to offer any special subjects to this group if it would mean taking time from fundamental sciences and mathematics. Therefore we believe we are on the right track in offering aeronautics to Senior Scientifics only, for they are the one group in the school who automatically take all our science and mathematics subjects. They are also the group who are most likely to make successful aviation cadets.

We feel that radio is a subject which is very likely to help any inductee, and we therefore offer this subject to Senior Generals. After the experience of this year we think that candidates for the radio course should study elementary electricity as a prerequisite, and so we have offered a half year course in elementary electricity to Junior Generals. These same boys will study elementary machines for a half year.

To fit meteorology into the curriculum has presented a difficult problem which has been solved for next year in this manner. One of our history teachers who is well qualified to teach meteorology will be given the classes including the Junior Scientific boys. Since these boys have studied a good deal of history in lower grades, about half of their history class time will be spent on the elements of meteorology.

Another item well worth reporting is the fact that the enrollment in physics for next year is double the present number in this important subject.

Milton Academy: Homer W. LeSourd, Aeronautics vs. Physics.

We are told that more than one-fourth, perhaps one-third of all the high schools in this country now offer courses in aeronautics. The movement originated in a joint committee from the C.A.A. and the Office of Education and it had the support of state and local authorities throughout the country. Some of our members will doubtless recall a speech that was made in Cambridge about a year ago by an ardent advocate of such a course. This speaker commented on the decline in the enrollment in physics, and attributed it to its technical and impractical character. On the other hand he said that aeronautics would appeal to boys as concrete, practical, and purposeful. He urged that aeronautics displace physics as a school subject and that it be made the dominant science for schools.

As a result of a year's experience in teaching the subject most of us are now better prepared to evaluate it as a school subject. We have been somewhat surprised to find that the army in its recommendations to schools has

made no mention of aeronautics. Its representatives have designated five areas as particularly important for the preparation of the future soldier; machines, electricity, radio, shop work, and automotive mechanics. We also note that both army and navy repeatedly urge more and better training in mathematics and physics. This change in emphasis for aeronautics to fundamental mathematics and physics is probably disconcerting to many teachers who are just now undecided as to what should be their plan of action for the next school year.

Shall it be physics or aeronautics? If but *one* of these is to be included in the curriculum, there is ample justification for the selection of physics in preference to aeronautics. However, we who have taught aeronautics have discovered that it is an excellent adjunct to physics, demonstrating, as it does, that physical laws, formulas, methods, and instruments are indispensable in this field. In our own school we admit to the aeronautics class only those who are qualified by reason of a satisfactory record in mathematics and who have taken physics previously or who are taking it concurrently. Under these circumstances moments of forces, vectors, Newton's laws of motion and many other parts of physics are in constant use, and students are gratified to find that physics provides the necessary background for an intelligent understanding and appreciation of the plane and of the air which supports it.

We are told that, in the training of pilots, the pace is fast, promotions are on the competitive basis and that there is a constant fear of the "washing machine." Most of the failures are due to class-room deficiencies. Our preflight course can at least provide the cadet with the vocabulary and the fundamental principles of flight and thus improve his chances of advancement. It is doubtless true that comparatively few of our students will become pilots but there is urgent need for a host of others who must become acquainted with the structure and operation of planes; navigators, bombardiers, gunners, radio operators, meteorologists, and mechanics. All of these need the basic knowledge which our school course in aeronautics gives.

The obvious conclusion is that aeronautics deserves a place in the curriculum of schools, at least for the duration of the war, and that we physics teachers should support the cause of preflight training in our schools but not at the expense of, nor as a substitute for *physics* itself.

Groton School: George H. Blackwell.

The courses offered in physics and preflight aeronautics at Groton School this past year have been determined partly by the fact that the writer was a newcomer on the Groton faculty in September. The school's chief science courses were a thoroughly war-conscious general chemistry for boys in both the fourth and fifth forms (tenth and eleventh grades) and a course in advanced physics for the sixth form (twelfth grade). These latter fellows had all taken previously a year of elementary physics. It

was felt that physics was greatly needed nowadays, because of the overwhelmingly large part it plays in modern warfare, and the consequent demand for it which the armed services are making.

In addition, there has been a voluntary preflight course since mid-years. Some thirty boys expressed interest and the intention of attending; the twelve or so who finally stuck by it through all the difficulties and distractions attendant upon a voluntary study were really very gratifying. This spring they contributed a fine automobile engine to the school laboratory. Finding a perfectly usable Ford car on the school dump, brought there recently in the scrap drive, they decided to salvage the motor and various other parts. These now repose in the physics lab. Thanks to the great interest of two boys, the motor was torn down completely during the last ten days of term, and is now ready for cleaning and assembling by the group next fall.

Since Groton's science curriculum is in the process of revision, next fall will see a rather different picture there. The fourth form will continue with chemistry at present, and a complete one-year course in physics will be offered in both the fifth and sixth forms, for those boys who have had no physics previously. In addition, those sixth formers who have already studied some physics will have opportunity to enroll in an advanced course, to concentrate on the topics of light, electricity, and communications, including a number of weeks of radio. 1943–44 will thus see more than three times as many boys studying physics in this school than did the previous year. This constitutes both a satisfaction and a challenge to the science department.

STEREOSCOPIC VIEWS OF AERIAL PHOTOGRAPHS

Adapted from notes furnished by MR. MELVIN BARNES

The use of the Fairchild F-71 Magnifying Stereoscope as an aid in the identification of features on vertical aerial photographs. (Figure 1.)

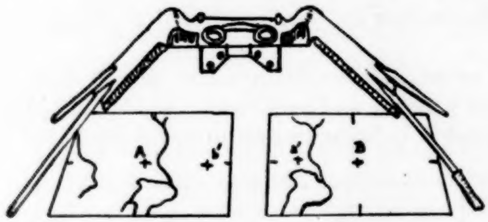


FIG. 1. Use of the Fairchild F-71 Magnifying Stereoscope.

DELIBERATE METHOD OF ORIENTING PICTURES

The center point of each photograph (points *A* and *B*, Figure 1) are located by means of the collimating marks registered on the prints.

The two photos are scanned and the center point of each located in the overlapping area of the other (points a' and b').

The left-hand photo is fastened to the table and a straightedge or scale placed along the two marked points on the photo.

Holding the straightedge in this position with one hand, one slides the right-hand photo so that its two marked points also fall along the same edge of the scale. The distance between A and a' is $9\frac{3}{4}$ inches.

The right-hand photo is fastened in position, and the stereoscope placed over the photos parallel to a line joining their centers. The photos should now fuse for stereoscopic vision.

For a period of some three or four years there have appeared almost daily in the papers and magazines throughout the country, pictures showing the destruction wrought by air power in Europe, Asia, and North Africa. These pictures have been both oblique and vertical aerial photographs.

Now an oblique aerial photograph is merely an exaggerated form of what one is able to see from a hilltop or a high building. It is an improved and economical substitute for a panoramic sketch and is usually quite intelligible to the average person.

However, because one is unaccustomed to seeing objects in plan, that is, viewing the landscape from a two- or three-mile altitude, the first impression of a vertical aerial photograph is that it is apparently cluttered with strange appearing shapes. So, in order to interpret a vertical photograph with any degree of accuracy and speed, one should become familiar with the horizontal as well as the more familiar vertical image of objects so that one can immediately identify any one feature without being confused by the others.

STEREOVISION

Objects on an ordinary single vertical photograph have a flat appearance which makes it difficult to distinguish between hills and valleys, but if two overlapping vertical photographs, a stereo-pair, are viewed under a mirror stereoscope, the effect of depth or relief is obtained. This is a great aid in the understanding and reading of vertical photographs and photomaps.

The ability to see stereoscopically comes quickly to most people, but others must use patience and perseverance to obtain it. Below are three exercises for practice in fusing two pictures with the naked eyes. (Figures 2, 3, and 4).

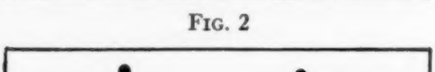


FIG. 2

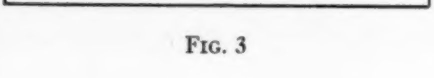


FIG. 3

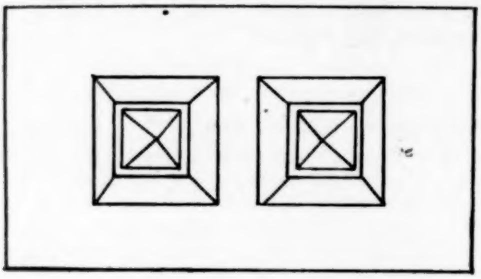


FIG. 4

Focus the eyes on a distant object and without changing the focus bring Figure 2 in front of the eyes and about 6 to 10 inches away. The dots will merge until apparently there is one dot. You will see three images, but fix your attention on the center one disregarding the other two. Using the same method try Figure 3. Figure 4 shows two geometric drawings. Fuse the pair of drawings by the same method as above. You should see a square pit with a pyramid sticking up out of the bottom making a three dimensional picture.

IDENTIFICATION OF TERRAIN FEATURES

Following are a few suggestions to aid in recognizing visible features of terrain from their images on a photograph, or in inferring the existence of hidden features by their characteristic effects on images of visible features.

(1) ORIENTATION

Facing the source of light the photograph or photographs should be turned so that shadows of objects fall toward you, thus simulating the lighting conditions as they occur in nature.

(2) SHAPE OF OBJECTS

In oblique photographs, objects appear in their familiar profile and are easily recognized. In vertical photographs, objects appear in plan, and a knowledge of their characteristic appearance is best obtained by comparison of the photographic image with the object on the ground, or by the map symbol representing it.

(3) RELATIVE SIZE OF OBJECT

Such as a car on a road, the width of roads, the size of house, etc.

(4) TONE, OR SHADE OF GRAY, IN WHICH OBJECT APPEARS

Tone is due almost entirely to the amount of light which an object reflects to the camera.

The more light reflected from an object toward the camera the whiter the image of the object appears on the photograph. A surface which reflects no light appears black on the photograph. Most smooth surfaces are good reflectors of light and appear white when the camera catches the rays, but will appear dark when the light is not reflected to the camera.

Rough surfaces reflect light at any different angles and the tone of such

a surface will depend on the nature of the object and the amount of rays caught by the camera. See Figure 5.

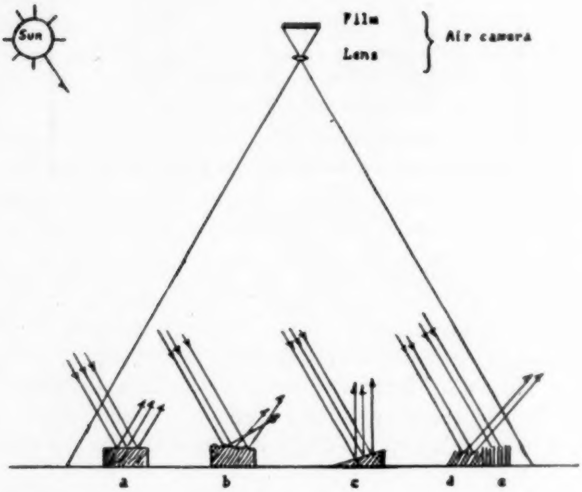


FIG. 5. (a) Smooth surface (Roads, Rivers, Lakes), (b) Rough surface (Ploughed fields), (c) Slanting surface (Roofs, Cliffs), (d) Flattened texture (grass), (e) Rough texture (rough water).

(5) SHADOW WHICH OBJECT CASTS

Objects cast shadows which reveal the shape of the object far better than the vertical view of the object itself, and for this reason the shadow is a most important consideration in the interpretation of vertical aerial photographs, because vertical dimensions shown by shadows are more characteristic than horizontal dimensions. See Figure 6.

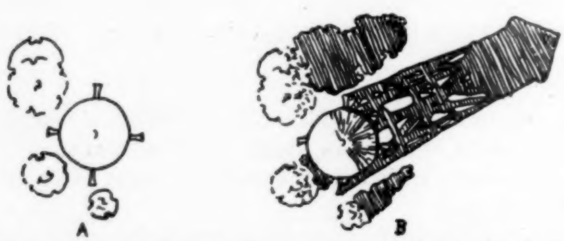


FIG. 6. (A) Objects without shadows. What are they? (B) Same objects with their shadows. Water tower and trees.

To do hard things without show of effort, that is the triumph of strength and skill.—*A. J. Rowland.*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

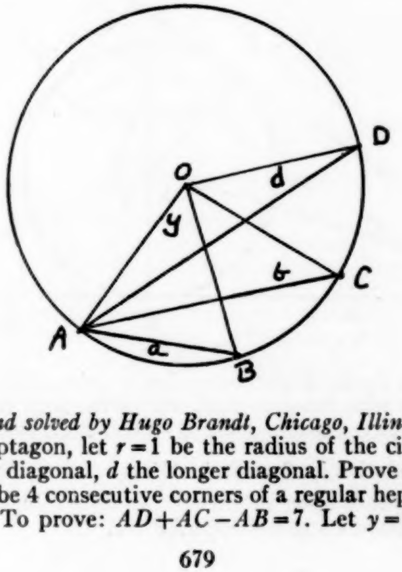
2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1796, 1808. *Harvey Rubinstein, Brooklyn, N. Y.*
1809. *M. Kirk, West Chester, Pa.*

Editor's Note: Another solution is offered in 1814 to which the use of decimals is avoided.



1814. *Proposed and solved by Hugo Brandt, Chicago, Illinois.*

In a regular heptagon, let $r=1$ be the radius of the circumcircle, a the side, b the shorter diagonal, d the longer diagonal. Prove $d+b-a=\sqrt{7}$.

Let A, B, C, D be 4 consecutive corners of a regular heptagon whose circumradius, $r=1$. To prove: $AD+AC-AB=7$. Let $y=180/7$ be the in-

scribed angle subtended by the side a. Let $\cos y = c$. Now $a = 2r \sin y$, $b = 2r \sin 2y$, $d = 2r \sin 3y$, $r = 1$. Let

$$x = d + b - a = 2(\sin 3y + \sin 2y - \sin y)$$

$$= 2 \sin y\left[(4c^2-1)+2c-1\right] = \frac{\sin y}{c}(8c^3+4c^2-4c). \qquad (1)$$

But $3\frac{1}{2}y = 90°$, therefore $\sin 3y = \sin 4y$, or in terms of y, $\sin y(4c^2-1) = \sin y \ (8c^3-4c)$.

$$\therefore \quad 4c^2 - 1 = 8c^3 - 4c \qquad (2)$$

Inserting (2) into (1)

$$x = \frac{\sin y}{c}(8c^2-1), \quad \text{square!}$$

$$x^2 = \left(\frac{1}{c^2}-1\right)(64c^4-16c^2+1) = -64c^4 + c^2(64+16) - (16+1) + \frac{1}{c^2}$$

$$= \left[-64c^4 + 80c^2 - 24 + \frac{1}{c^2}\right] + 7.$$

The term in brackets equals zero, since

$$\left[-64c^4+80c^2-24+\frac{1}{c^2}\right] = \left(-8c-4+\frac{4}{c}+\frac{1}{c^2}\right)(8c^3-4c^2-4c+1)$$

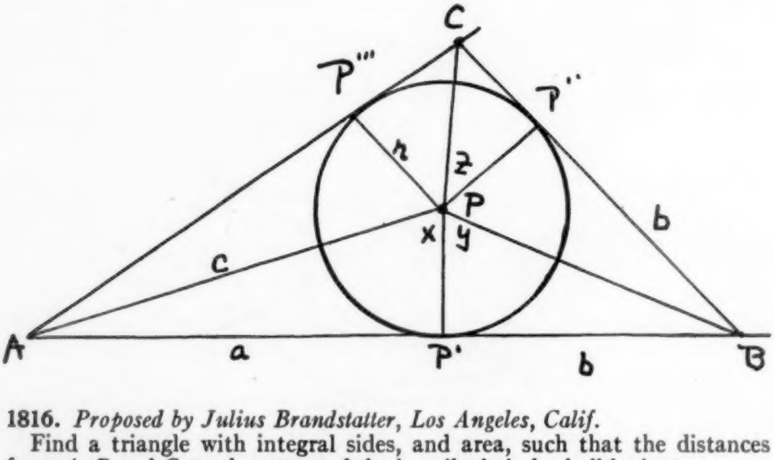
and from (2)

$$8c^3 - 4c^2 - 4c + 1 = 0$$

$$\therefore \quad x^2 = 7; \qquad x = \sqrt{7};$$

$$d + b - a = \sqrt{7}.$$

Editor's Note: A general solution to this interesting problem, 1816 is offered.



1816. *Proposed by Julius Brandstatter, Los Angeles, Calif.*

Find a triangle with integral sides, and area, such that the distances from A, B and C, to the center of the inscribed circle shall be integers.

Solution by Francis L. Miksa, Aurora, Ill.

The solution depends upon a choice of two right integral triangles $AP'P$ and $BP'P$ which have a common side $PP' = r$.

Having fixed the choice of those two triangles we can proceed as follows:

$$z=\tfrac{1}{2}[360-(2x+2y)]=180^\circ-(x+y). \tag{1}$$

Now

$$\cos y=\frac{r}{d}; \qquad \sin y=\frac{b}{d}; \qquad \tan y=\frac{b}{r};$$

$$\cos x=\frac{r}{c}; \qquad \sin x=\frac{a}{c}; \qquad \tan x=\frac{a}{r};$$

In terms of above

$$\cos z=-\cos(x+y)=-\left(\frac{r^2-ab}{dc}\right)=\frac{ab-r^2}{cd}$$

$$\tan z=-\tan(x+y)=\frac{(a+b)r}{ab-r^2}.$$

Now

$$CP=\frac{r}{\cos z}=\frac{rdc}{ab-r^2} \tag{2}$$

$$CP'''=CP''=r\tan z=\frac{r^2(a+b)}{ab-r^2} \tag{3}$$

$$AC=a+\overline{C}P''=\frac{b(a^2+r^2)}{ab-r^2} \tag{4}$$

$$BC=b+\overline{C}P''=\frac{a(b^2+r^2)}{ab-r^2}. \tag{5}$$

After multiplying all lengths by $(ab-r^2)$ we get an integral triangle whose angle bisectors, and area are all integral:

$$AC=b(a^2+r^2)$$
$$BC=a(b^2+r^2)$$
$$AB=(a+b)(ab-r^2)$$
$$AP=c(ab-r^2)$$
$$BP=d(ab-r^2)$$
$$CP=cdr$$
$$\text{Area}=abr(a+b)(ab-r^2).$$

Example. Using two pythagorean triangles whose sides are $a=6$, $b=15$, $c=10$, $d=17$, $r=8$ you get an integral triangle whose sides if divided by 2 are 750, 867, 273. These fulfills all the conditions. The number of such triangles seems to be unlimited.

Reference: Carmichael, Diophantine Analysis, ff. 11–13.

1819. *Proposed by Julius Brandstatter, Los Angeles, Calif.*

For what values of k is $\Sigma(1/x^k)$ convergent and divergent?

Solution by the proposer

Let $f(x)=1/x^k$. This form has the properties for the integral test of Cauchy.

(1) For $k>1$;

$$\int_1^n \frac{dx}{x^k}=\frac{1}{(1-k)n^{k-1}}-\frac{1}{1-k}.$$

Hence;

$$\lim_{n\to\infty}\int_1^n \frac{dx}{x^k}=\frac{1}{k-1}.$$

(2) For $k=1$;

$$\int_1^n \frac{dx}{x^k}=\log n,$$

and it increases without limit with n.

(3) For $k<1$;

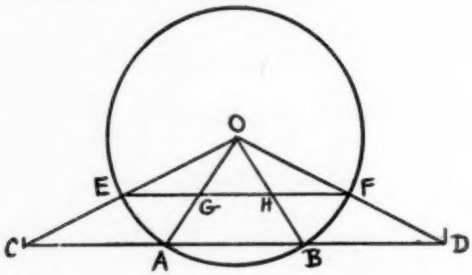
$$\int_1^n \frac{dx}{x^k}=\frac{n^{1-k}}{1-k}-\frac{1}{1-k}. \quad \text{Hence} \quad \lim_{n\to\infty}\int_1^n \frac{dx}{x^k}=\infty.$$

Therefore $\Sigma 1/n^k$ is convergent for $k>1$ and divergent for $k\leq 1$.

A solution was offered also by Hugo Brandt, Chicago, Ill.

1820. *Proposed by Fred Jones, Scott's Corners, N. Y.*

Construct a chord of a circle which shall be trisected by the sides of a given central angle of the circle.



Solution by D. F. Wallace, St. Paul, Minn.

Let O be the center of a circle and AOB a given central angle, OA and OB being radii.

Draw AB and produce AB in both directions to C and D, making $AC=BD=AB$.

Draw CO and DO interesecting the circle at E and F respectively.

Draw EF intersecting OA at G and OB at H.

Then EF is the chord required.

Proof: EF is parallel to CD, proof of which is quite simple and omitted.

Therefore $EG:GH:HF=CA:AB:BD$. But $CA=AB=BD$. Therefore $EG=GH=HF$. Therefore EF is trisected by the sides of the given central angle.

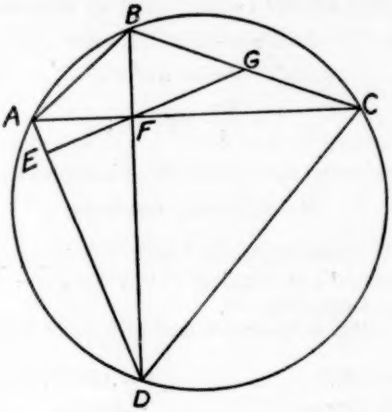
Solutions were offered also by Elizabeth Andrews, Olmsted Falls, Ohio and Hugo Brandt, Chicago, Ill., Morris J. Chernofsky, Brooklyn, N. Y.

1823. *Proposed by Nettie Darling, Lodi Center, N. Y.*

If the diagonals of an inscribed quadrilateral are perpendicular to each other, any line through their intersection perpendicular to one side bisects the opposite side. This is a theorem from Brahmagupta, an Indian mathematician of the seventh century A.D.

Let GE be perpendicular to AD. $\angle AFE$ and $\angle ADF$ are both complementary to $\angle DAF$ and hence are equal.

$\angle BCA$ and $\angle ADB$ are both measured by $\frac{1}{2}AB$. Hence, $\angle BCA = \angle ADB = \angle AFE = \angle CFG$. Therefore $FG=GC$. In like manner, $\angle CBD = \angle DAC = \angle DFE = \angle BFG$. Therefore $BG=FG=GC$.

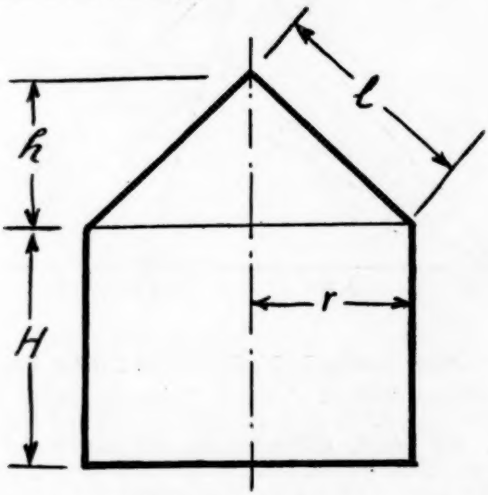


Solution by David Rappaport, Chicago, Ill.

Solutions were offered also by Hugo Brandt, Chicago, Ill.; M. Kirk, West Chester, Pa.; D. F. Wallace, St. Paul Minn.; Morris J. Chernofsky, Brooklyn, N. Y.

1824. *Proposed by Hugo Brandt, Chicago, Ill.*

An oil can is cylindrical in its lower portion and conical in its upper portion. Its surface is $S=\pi R^2$. Its volume is to be a maximum. Find r, H, h and l in terms of R, where r is base radius, H cylinder altitude, h cone altitude, and l slant height of cone. Also find $\cos\alpha$, where α is the apex angle and find the maximum volume.



Solution by the proposer

$$S=r^2\pi+2r\pi h+r\pi l.$$

$$V=\frac{r^2\pi}{3}(3H+h).$$

Let $r=aR$; $H=bR$; $h=cR$; $1=dR$. Inserting these above we get:

$$S=R^2\pi(a^2+2ab+ad)=R^2\pi$$

$$\therefore \quad a^2+2ac+ad=1. \qquad (1)$$

$$V=\frac{R^3\pi}{3}a^2(3b+c);$$

if this is to be a maximum, then, since $R^3\pi/3$ is constant,

$$M=a^2(3b+c), \text{ a maximum.} \qquad (2)$$

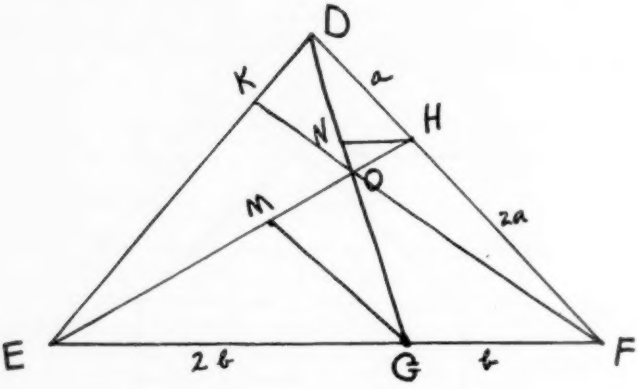
Assuming a to be constant, while b and c are variable, and considering $1^2=h^2+r^2$, hence $d^2=c^2+a^2$, making $a^2+2ac+a\sqrt{a^2+c^2}=1$, we take differentials of this and equation (2),

After the usual calculus procedure and with much labor, one obtains the results:

$r=.437R$	$V=.1457R^3\pi$ (max.)
$H=.6325R$	$d=96° 23'$
$h=.391R$	
$l=.5865R$	

1821. *Proposed by Grace Ansley, Montreal, Canada.*

In triangle DEF, G is taken on side EF such that $EG=2GF$, and H is on side FD such that $FH=2xHD$. DG and EH intersect in O. Prove that $\triangle DOH/\triangle DEF=1/21$. A solution by Euclidean Geometry is desired.



First Solution by M. Kirk, West Chester, Pa.

From the triangle $NH \parallel EF$, $GM \parallel FD$. Using the similar triangles DNH and DGF, EMG and EFH, DOH and MOG, NOH and EOG, one obtains: $NH=b/3$, $MG=4a/3$, $MO=4/3OH$, $EO=6\cdot OH$. Also $\triangle EHF=2/3\triangle DEF$ and $\triangle DGF=1/3\triangle DEF$. Hence the following equations result: Area DOH = Area DNH + Area NOH = Area DNH + 1/36 Area EOG = Area DNH + 1/36 (Area EMG + Area MOG) = Area DNH + 1/36 Area EMG + 1/36 Area MOG = Area DNH + 1/36 Area EMG + 4/81 Area DOH. Therefore 77/81 Area DOH = 1/9 Area DGF + 1/81 Area EFH = 1/27 Area DEF + 2/243 Area DEF = 11/243 Area DEF. Therefore Area DOH = 1/21 Area DEF.

Second Solution by D. F. Wallace, St. Paul, Minn.

Through O draw FK meeting DE at K. By Ceva's theorem we have:

$$\frac{KE}{DK}\cdot\frac{HD}{FH}\cdot\frac{GF}{EG}=1. \quad \text{Hence} \quad \frac{KE}{DK}=\frac{FH}{HD}\cdot\frac{EG}{GF}=2\cdot 2=4. \tag{1}$$

Treating FK as a transversal of $\triangle EDH$, we have by Menelaus' theorem:

$$\frac{OH}{EO}\cdot\frac{FD}{HF}\cdot\frac{KE}{KD}=1. \text{ Hence } \frac{OH}{EO}=\frac{HF}{FD}\cdot\frac{KD}{KE}=2/3\cdot 1/4=1/6 \quad \therefore \quad \frac{OH}{KE}=1/7 \tag{2}$$

$$\frac{\triangle DOH}{\triangle EDH}=\frac{OH}{EH}=1/7 \tag{3}$$

$$\frac{\triangle EDH}{\triangle DEF}=\frac{HD}{FD}=1/3. \tag{4}$$

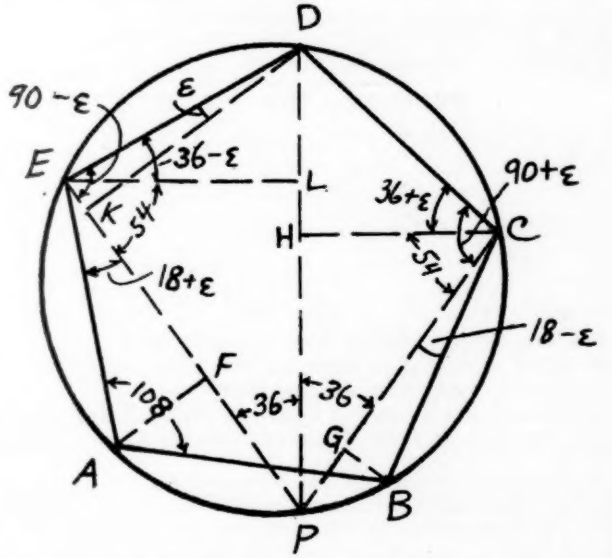
Multiplying (3) by (4) we have

$$\frac{\triangle DOH}{\triangle DEF}=1/21.$$

Solutions were offered also by Hugo Brandt, Chicago, Ill.; Eva Baxter, Havana, Cuba; Olive Norton, East Syracuse, N. Y., and the proposer.

1822. *Proposed by D. F. Wallace, St. Paul, Minn.*

$ABCDE$ is a regular pentagon inscribed in a circle and P is a point on the minor arc subtended by AB. AF and DK are perpendicular to PE; BG is perpendicular to PC, and CH and EL are perpendicular to PD. Prove that $AF+BG+DK=CH+EL$.



Solution by Hugo Brandt, Chicago, Ill.

Let P be nearer B than A so that PD is not a diameter. Hence $\angle DEP$ is acute and $\angle DCP$ is obtuse. Let $DEP=90°-e$ and $DCP=90°+e$.

Hence $\angle EDK=e$. From geometry an angle of the polygon is 108°, a

central angle subtended by a side is 72°; and an inscribed angle subtended by a side is 36°.

Hence $\angle LEP = \angle HCP = 54°$. Also $\angle DEL = (90° - e) - 54° = 36° - e$ and $\angle DCH = 36 + e$.

Again $\angle AEP = 108° - (90° - e) = 18° + e$.

Likewise $\angle BCP = 18° - e$.

If the side of the polygon is unity, then

$$AF = \sin (18° + e), \quad BG = \sin (18° - e), \quad DK = \cos e \quad \text{and}$$
$$EL = \cos (36° - e), \quad CH = \cos (36° + e).$$

By conditions of the problem, the following equation must be true:

$$\sin (18 + e) + \sin (18 - e) + \cos e = \cos (36° - e) + \cos (36° + e).$$

By trigonometry this reduces to:

$$4 \sin^2 18° + 2 \sin 18° - 1 = 0, \quad \text{from which} \quad \sin 18° = \frac{-1 \pm \sqrt{5}}{2}.$$

Let $18° = x$, then using the relation $\sin 2x = \cos 3x$, the above value of $\sin 18°$ is established.

A solution was offered also by the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below:

1821, 3. *K. A. G. Miller, Upper Canada College, Toronto.*

1820, 1, 3. Harvey Rubenstein, Brooklyn, N. Y.

PROBLEMS FOR SOLUTION

1837. *Proposed by J. Frank Arena, Hardin, Ill.*

Solve for x:

$$\sqrt[3]{a-x} + \sqrt[3]{b-x} = \sqrt[3]{a+b-2x}$$

1838. *Proposed by J. Frank Arena, Hardin, Ill.*

Solve for $a+b$:

$$a^2 + b^2 = 7$$
$$a^3 + b^3 = 10$$

1839. *Proposed by Alfred Seeley, Hoyt's Corners, N. Y.*

If $x = c \tan \theta$, show that $(x^2 + c^2)^2 . \sin 4\theta = 4cx(c^2 - x^2)$

1840. *Proposed by Sadie Peck, Detroit, Mich.*

If P is a point in the side GF of square $DEFG$, such that $DP = FP + FE$, prove that the line from D to M, the mid point of EF, bisects angle PDE.

1841. *Proposed by G. E. Speer, Lodi, N. Y.*

Show that the length of an arc of the parabola $y^2 = 4ax$, which is intercepted between the points of intersection of the parabola and $3y = 8x$ is $a(\log 2 + 15/16)$.

1842. *Proposed by L. W. Ayers, Adrian, Iowa.*

Find the sum to infinity of

$$1 + \frac{2^3}{2!} + \frac{3^3}{3!} + \frac{4^3}{4!} + \cdots.$$

BOOKS RECEIVED

ELEMENTARY MATHEMATICS FOR THE MACHINE TRADES, by John J. Weir, B.S., M.A., *Instructor, Sperry Gyroscope Company*. Cloth. Pages viii+193. 13.5×20.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.60.

PRINCIPLES AND PRACTICE OF RADIO SERVICING, by H. J. Hicks, M.S., *Associate Radio Engineer, Aircraft Radio Laboratory*, Wright Field, Dayton. Second Edition. Cloth. Pages xii+391. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.50.

ESSENTIALS OF PLANE AND SPHERICAL TRIGONOMETRY, by Clifford Bell and Tracy Y. Thomas, *University of California, Los Angeles*. Cloth. Pages vi+142. 13.5×21.5 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $1.80.

MATHEMATICS FOR MACHINISTS, by R. W. Burnham, *Principal, Haaren High School, New York City*. Second Edition. Cloth. Pages xii+253. 12×18 cm. 1943. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.50.

CONSUMER EDUCATION, Edited by James E. Mendenhall, *Office of Price Administration, Washington, D. C.*, and Henry Harap, *George Peabody College for Teachers*. Cloth. Pages x+399. 14×21.5 cm. 1943. D. Appleton-Century Company, 35 W. 32nd Street, New York, N. Y. Price $2.50.

MODERN PHYSICS, by Charles E. Dull, *Head of Science Department, West Side High School, and Supervisor of Science for the Junior and Senior High Schools, Newark, New Jersey*. Revised. Cloth. Pages x+598+xxv. 15×23.5 cm. 1943. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $2.00.

AN INTRODUCTION TO PLANE GEOMETRY, by H. F. Baker, Sc.D., LL.D., F.R.S., *Emeritus Professor of Astronomy and Geometry and Fellow of St. John's College in the University of Cambridge*. Cloth. Pages viii+382. 14×22 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.00.

RADIO EDUCATION PIONEERING IN THE MID-WEST, by Albert A. Reed, LL.D., *Formerly Deputy State Superintendent of Public Instruction, Lincoln, Nebraska; Director-Emeritus, University Extension Division, University of Nebraska; Professor Emeritus, Secondary Education, University of Nebraska*. Cloth. 128 pages. 12×20 cm. 1943. Meador Publishing Company, 324 Newbury Street, Boston, Mass. Price $2.00.

PRACTICAL PHYSICS, by Marsh W. White, Ph.D., *Editor, Professor of Physics;* Kenneth V. Manning, Ph.D., *Assistant Supervisor of Physics Extension;* Robert L. Weber, Ph.D., *Assistant Professor of Physics;* R. Orin Cornett, Ph.D., *Lecturer in Electronics, Harvard University;* and Others on The Physics Extension Staff. Prepared under the Direction of The Division of Arts and Science Extension, The Pennsylvania State College. Cloth. Pages x+365. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.50.

FUNDAMENTALS OF ENGINEERING DRAWING, by Warren J. Luzadder, *Assistant Professor of Engineering Drawing, Purdue University and Member of Society for the Promotion of Engineering Education*. Cloth. Pages xiii+568. 15×23 cm. 1943. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $3.00.

MACHINES. Written to Conform to the Preinduction Training Course in Fundamentals of Machines as Prepared by the War Department by Charles R. Wallendorf, *Administrative Assistant, Woodrow Wilson Vocational High School, Jamaica, New York;* Frank Stewart, *Department of Applied Physics, Brooklyn Technical High School, New York;* George

Luedeke, *Supervisor of Shop Subjects in Vocational High Schools, Board of Education, New York, N. Y.;* and Dominic M. Chiarello, *Department of Applied Electricity, Brooklyn Technical High School, New York.* Cloth. Pages vii+300. 15.5×23.5 cm. 1943. American Book Company, 360 N. Michigan Avenue, Chicago, Ill.

AUTOMOTIVE MECHANICS—II. Written to Conform to the Preinduction Training Course in Fundamentals of Automotive Mechanics as Prepared by the War Department by Clarence G. Barger, *Instructor of Automotive Mechanics, Brooklyn High School of Automotive Trades, Brooklyn, New York.* Cloth. Pages viii+174. 16×23.5 cm. 1943. American Book Company, 360 N. Michigan Avenue, Chicago, Ill.

DIFFERENTIAL AND INTEGRAL CALCULUS, by Clyde E. Love, Ph.D., *Professor of Mathematics in the University of Michigan.* Fourth Edition. Cloth. Pages xv+483. 15×23.5 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.25.

THE CHEMICAL FORMULARY. A Collection of Valuable, Timely, Practical Commercial Formulae and Recipes for Making Thousands of Products in Many Fields of Industry. Volume VI. Editor-in-Chief, H. Bennett. Cloth. Pages xx+636. 13.5×21.5 cm. 1943. The Chemical Publishing Company, Inc., 234 King Street, Brooklyn, N. Y. Price $6.00.

ELEMENTARY STATISTICAL METHODS, by Helen M. Walker, *Professor of Education, Teachers College, Columbia University.* Cloth. Pages xxv+368. 15×23.5 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $2.75.

ENGINEERING PROBLEMS ILLUSTRATING MATHEMATICS. A Project of the Mathematics Division of the Society for the Promotion of Engineering Education, John W. Cell, *Chairman of Committee, Associate Professor of Mathematics in the College of Engineering, North Carolina State College.* Cloth. Pages xi+172. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.75.

SOME SOURCES OF CHILDREN'S SCIENCE INFORMATION. An Investigation of Sources of Information and Attitudes Toward such Sources as Used or Expressed by Children, by Catharine Bergen, Ph.D. *Teachers College, Columbia University Contributions to Education,* No. 881. Cloth. 72 pages. 15×23 cm. 1943. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $1.75.

RADIO NETWORKS AND THE FEDERAL GOVERNMENT, by Thomas Porter Robinson. Cloth. Pages x+278. 15×23 cm. 1943. Columbia University Press, Morningside Heights, New York, N. Y. Price $3.50.

RADIO TROUBLESHOOTER'S HANDBOOK, by Alfred A. Ghirardi, Author, *The Radio Physics Course, Modern Radio Servicing, Radio Field Service Data.* Third Revised, Enlarged Edition. Cloth. Pages viii+744. 20.5×27.5 cm. 1943. Radio and Technical Publishing Company, 45 Astor Place, New York, N. Y. Price $5.00.

COLLEGE ALGEBRA, by Frank M. Morgan, *Director of Clark School, Hanover, New Hampshire, Formerly Assistant Professor of Mathematics, Dartmouth College.* Cloth. Pages vi+368. 14×21.5 cm. 1943. American Book Company, 88 Lexington Avenue, New York, N. Y. Price $2.00.

PLANE TRIGONOMETRY WITH TABLES, by Donald H. Ballou, Ph.d., *Assistant Professor of Mathematics, Middlebury College,* and Frederick H. Steen, Ph.D., *Assistant Professor of Mathematics, Allegheny College.* Cloth. Pages vi+123+7+84. 14.5×22.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $2.00.

MATHEMATICS FOR THE SHEET METAL WORKER, by Clayton E. Buell, B.S., M.Ed., *Instructor of Related Trade Mathematics, Science, and Drawing Apprentice School, U. S. Navy Yard, Philadelphia, Pa., and Edward Bok*

Vocational School, Philadelphia, Pa. Cloth. Pages vii+199. 13×20.5 cm. 1943. Pitman Publishing Corporation, 2 West 45th Street, New York, N. Y. Price $2.00.

ELEMENTARY APPLIED ELECTRICITY, by L. Raymond Smith, *Instructor in Industrial Physics, William L. Dickinson High School, Jersey City, N. J., Member American Society of Mechanical Engineers.* Third Edition. Cloth. Pages xiii+311. 12×19 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

SCIENCE, by Ira C. Davis, *Head of Department of Science, University High School, Assistant Professor in the Teaching of Science, School of Education, University of Wisconsin;* and Richard W. Sharpe, *Formerly Instructor in Science, George Washington High School, New York City.* Revised Edition. Cloth. Pages xi+495. 15×23.5 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $1.84.

TEACHER'S MANUAL FOR DAVIS AND SHARPE'S SCIENCE, by Ira C. Davis, *Head of Department of Science, University High School, Assistant Professor in the Teaching of Science, School of Education, University of Wisconsin.* Paper. 45 pages. 15.5×23.5 cm. 1937. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y.

LOOK AND LEARN, by Wilbur L. Beauchamp, Gertrude Crampton. Cloth. 72 pages. 19.5×26 cm. 1943. Scott, Foresman and Company, 623 So. Wabash Avenue, Chicago, Ill. Price 84 cents.

REVIEW ARITHMETIC: WHOLE NUMBER AND FRACTIONS, by Guy T. Buswell, William A. Brownell, Lenore John. Textbook I. Paper. Pages vi+173. 13×19 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price 60 cents.

REVIEW ARITHMETIC: DECIMALS, PER CENTS, AND APPLICATIONS OF ARITHMETIC, by Guy T. Buswell, William A. Brownell, Lenore John. Textbook II. Paper. Pages vi+215. 13×19 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price 60 cents.

PILOTING AND MANEUVERING OF SHIPS, by Lyman M. Kells, Ph.D., *Associate Professor of Mathematics;* Willis F. Kern, *Associate Professor of Mathematics;* and James R. Bland, *Associate Professor of Mathematics,* All at the United States Naval Academy. Cloth. Pages xviii+181. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

PREPARE YOURSELF: PHYSICS EXPERIMENTS WITH PRACTICAL APPLICATIONS, by Lawrence F. Tuleen and George S. Porter, *Instructors of Natural Science, J. Sterling Morton High School and Junior College, Cicero, Illinois;* and Arthur Houston, *Instructor of Physics, Keene High School, Keene, New Hampshire.* Paper. Pages vi+298. 20×27 cm. 1943. Scott, Foresman and Company, 623 So. Wabash Avenue, Chicago, Ill. Price 96 cents.

FIRST-YEAR ALGEBRA, by Raleigh Schorling, *Head of Department of Mathematics, The University High School and Professor of Education, University of Michigan;* Rolland R. Smith, *Specialist in Mathematics, Public Schools, Springfield, Massachusetts;* with the cooperation of John R. Clark, *Teachers College, Columbia University.* Cloth. Pages xiv+466. 13.5×20.5 cm. 1943. World Book Company, Yonkers-on-Hudson, N. Y. Price $1.56.

1000 PRE-FLIGHT PROBLEMS, by W. H. Thompson, *The Hartford Connecticut Public Schools,* and M. L. Aiken, *The Sedgwick School West Hartford, Connecticut.* Paper. Pages xv+160. 13.5×21 cm. 1943. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price 88 cents, cloth $1.20.

UNIFIED PHYSICS, MATTER IN MOTION, by Gustav L. Fletcher, *Chairman, Department of Physical Science, James Monroe High School, New York, N. Y.;* Irving Mosbacher, *Late Chairman, Department of Physical*

Science, Morris High School, New York, N. Y.; and Sidney Lehman, *Department of Physical Science, James Monroe High School, New York, N. Y.* Revised Edition. Cloth. Pages xii+713. 13×20 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $1.80.

PLANE AND SPHERICAL TRIGONOMETRY, by Alfred L. Nelson, *Professor of Mathematics,* and Karl W. Folley, *Associate Professor of Mathematics, Wayne University.* Revised Edition. Cloth. Pages xiv+247+135. 13.5×21 cm. 1943. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $2.40.

MAN AND HIS PHYSICAL UNIVERSE, by Frank Covert Jean, Ezra Clarence Harrah and Fred Louis Herman, *Colorado State College of Education,* with the Editorial Collaboration of Samuel Ralph Powers, *Teachers College, Columbia University.* Cloth. Pages viii+608. 15×22.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $3.25.

PLANE GEOMETRY, by A. D. Theissen, *Formerly Instructor in Mathematics, Marquette University High School,* and Louis A. McCoy, *Head Master, Girls' High School, Boston, Massachusetts.* Cloth. Pages viii+344. 13×19 cm. 1943. Loyola University Press, 3441 North Ashland Avenue, Chicago, Ill. Price $1.40.

MATHEMATICS ESSENTIAL TO ELECTRICITY AND RADIO, by Nelson M. Cooke, *Lieutenant, United States Navy; Member, Institute of Radio Engineers,* and Joseph B. Orleans, *Head of Department of Mathematics, George Washington High School, New York, N. Y.* Cloth. Pages x+418. 14.5×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.40.

BUSINESS MATHEMATICS, by Cleon C. Richtmeyer, *Ph.D., Head of Department of Mathematics, Central Michigan College of Education, Mt. Pleasant, Michigan,* and Judson W. Foust, Ph.D., *Assistant Professor of Mathematics, Central Michigan College of Education, Mt. Pleasant, Michigan.* Second Edition. Cloth. Pages xv+401. 13.5×20.5 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.75.

MATHEMATICS OF FLIGHT, by James Naidich, *Chairman, Department of Mathematics, Manhattan High School of Aviation Trades, New York, N. Y.* Cloth. Pages x+409. 15×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.20.

RADIO MATERIAL GUIDE, by Francis E. Almstead, Lieut., U.S.N.R., *U. S. Naval Training School, Noroton Heights, Connecticut,* and F. R. L. Tuthill, Comdr., U.S.N.R., *Eastern Sea Frontier Command.* Cloth. Pages xi+242. 12.5×19 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

LABORATORY EXPLORATIONS IN GENERAL ZOOLOGY, by Karl A. Stiles, M.S., Ph.D., *Bert Bailey Professor of Biology and Chairman of the Division of Natural Sciences, Coe College.* Paper. Pages x+305. 20×28 cm. 1943. The Macmillan Book Company, 60 Fifth Avenue, New York, N. Y.

EDUCATORS GUIDE TO FREE FILMS, Compiled and Edited by Mary Foley, Co-author of *Educators Question Book,* and John W. Diffor, M.A., *University of Michigan, Visual Education Director, Randolph High School, Randolph, Wisconsin.* Third Edition. Paper. 169 pages. 20×27.5 cm. 1943. Educators Progress League, Box 226, Randolph, Wis.

A COURSE IN THE SLIDE RULE AND LOGARITHMS, by E. Justin Hills, *Los Angeles City College.* Paper. Pages iv+108. 14×22.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price 75 cents.

THE SCIENCE OF NUTRITION, by Henry C. Sherman, *Mitchell Professor of Chemistry, Columbia University.* Cloth. Pages x+253. 13.5×21.5 cm. 1943. Columbia University Press, Morningside Heights, New York. Price $2.75.

RADIO-II, by R. E. Williams, *Manager, School Service, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.*, and Charles A. Scarlott, Editor, *Westinghouse Engineer*. Cloth. Pages vii+164. 15.5×23.5 cm. 1943. American Book Company, 360 No. Michigan Ave., Chicago, Ill.

COMMERCIAL ALGEBRA, by Hugh E. Stelson, Ph.D., *Professor of Mathematics, Kent State University* and Harold P. Rogers, M.A., *Assistant Professor of Mathematics, Kent State University*. Cloth. Pages xi+283. 14×21.5 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York. Price $2.50.

MATHEMATICS FOR VICTORY, by Virgil S. Mallory, *Professor of Mathematics and Instructor in the College High School, State Teachers College, Montclair, N. J.* Cloth. Pages vii+430. 13×19 cm. 1943. Benj. H. Sanborn & Co., 221 East 20th Street, Chicago 16, Illinois. Price $1.64.

COMPLEXITY OF MENTAL PROCESSES IN SCIENCE TESTING, by Frederick Thomas Howard, Ph.D. Cloth. Pages v+54. 15×23 cm. 1943. Bureau of Publications, Teachers College Columbia University, New York City. Price $1.75.

PLANE AND SPHERICAL TRIGONOMETRY WITH TABLES, by Donald H. Ballou, Ph.D., *Assistant Professor of Mathematics, Middlebury College* and Frederick H. Steen, Ph.D., *Associate Professor of Mathematics, Allegheny College*. Cloth. Pages vi+179+84. 14.5×22.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $2.40.

BUSINESS MATHEMATICS FOR COLLEGE STUDENTS by George H. Whiteaker, M.A., *Assistant Professor of Mathematics, School of Commerce, Accounts and Finance, University of Denver*. Paper. Pages xi+184. 21×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $1.50.

BOOK REVIEWS

ANALYTICAL EXPERIMENTAL PHYSICS, by Harvey Brace Lemon, *Professor of Physics, The University of Chicago* and Michael Ference, Jr., *Assistant Professor of Physics, The University of Chicago*. Cloth. Pages xvi+584. 23×30 cm. 1943. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price $5.75.

The above description shows this to be a most extraordinary textbook of physics. It contains 584 pages but this is equivalent to nearly 800 pages of the typical physics text. It was prepared as a second-year text for professional science students and has been in use in various provisional forms at the University of Chicago for eight years, in classes taught by twenty different instructors, all of whom made criticisms and suggested alterations. Thus the book comes to the public much more as a finished product than is the case with most textbooks. It covers the great majority of the topics treated in other texts but the method is quite analytical rather than merely descriptive. The students are assumed to be interested in the topic treated, to have some idea of the field of physics, and to have the ability to follow an analytical development. Each chapter includes many excellent problems based on the discussion. An extraordinary feature of the book is the inclusion of many pages using motion picture film as the illustration material with discussions, including graphs, equations, tables of data, and explanations. The mathematics used is practically all covered in high school algebra and geometry with a few trigonometric equations. Notations from the calculus are used rarely in electricity and light. A mathematical appendix of about sixteen pages covers all the trigonometry and calculus used as well as other valuable ideas from trigonometry and geometry.

For classes not having time to cover the entire course approximately one hundred topics have been starred in the table of contents. These may readily be omitted. Many of these are found in the sections on sound and light. All topics in the entire chapter "Scientific Aspects of Musical Art" are starred. Few of the ordinary physics students will object to omission of this chapter. It is the only section in which the authors seem to have carried into the book a section not of general interest and importance to the general physics student.

In going over this text the reviewer has been very favorably impressed with the selection of topics, emphasis on important features, excellent drawings and explanations, and the problem selection. The language is well chosen, clear and precise. Very few errors of any type were noted. We are pleased to recommend it for the engineering and other groups emphasizing physics. It was originally published to sell at $7.00 but because of its phenomenal success the price has been reduced to $5.75 for the second printing.

G. W. W.

ELEMENTS OF RADIO, by Charles I. Hellman, *Instructor in Physics, High School of Science, New York City*. Cloth. Pages xiii+318. 15×23 cm. 1943. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.00.

Here is an excellent text for the large body of young men and women who are now confronted with the great problem of preparing for important action in the least possible time. Men who can operate and repair radio sets are an appreciable part of our armed forces. Great numbers of both men and women are needed in our factories and repair shops. Over a year ago the War Department presented an outline for study. The author of this book was a member of the committee that prepared the outline and this book follows the report closely. See the War Department Outline PIT 201. Chapter 8 covers the material outlined in the committee report under topics viii and ix, and Chapter 18, "Some Applications of Electronics," gives additional material not covered in the War Department outline.

The book is adapted for use in high schools but will be found very useful for students beyond high school age who have not taken work in this field. It presupposes a year of high school physics, but this is not necessary for the better students who are serious and willing to do the work necessary to a thorough understanding of the subject. Algebra and trigonometry are used throughout the text where they are important in explaining the theory, but the necessary trigonometry can be mastered in a short time. Problems and questions are inserted at points where they will be of greatest value in making and fixing the theoretical discussion. The book has been carefully prepared and is practical. The many colleges now giving elementary courses in radio for service men will find it well adapted to their needs.

G. W. W.

SCIENCE, by Ira C. Davis, *Head, Department of Science, University High School, Associate Professor in the Teaching of Science, School of Education, University of Wisconsin*, and Richard W. Sharpe, *Formerly Instructor in Science, George Washington High School, New York City*. Cloth. Pages xiv+495. 15.25×23.5 cm. 1943. Revised. Henry Holt and Company, New York. Price $1.84.

Originally issued in 1936, this 1943 revision contains alterations so limited in nature that the table of contents and even the paging are unchanged, save for the addition of a glossary. This has the advantage that

present supplies may be added to or replaced in part by the new edition without embarrassment about paging.

Teachers acquainted with the older editions will know the strengths and weaknesses of this one. It is among the best of ninth grade general science texts. It is more truly a book dealing with our immediate environment than any other this reviewer has encountered. Rather than dwelling upon the exotic and the sensational, it concentrates upon the things we see about us. For example, the study of astronomy contains no mention of spiral nebulae, comets and other phenomena observable chiefly to astronomers; instead there is a most praiseworthy chapter on time and direction, of especial value in this day of the airplane.

On the adverse side, one finds the book touching upon too many topics. This requires a conciseness of expression which makes for difficulty with pupils who are not average or better. This weakness is compensated for by good illustrations, by good make up, and by good questions and study aids.

The most extensive changes in the new edition occur in the special feature which heads each chapter and which is called, "The Story of Progress and Discovery." For the most part these sections have been entirely rewritten in simpler language and are less comprehensive. They are no longer printed in italic but in a type face slightly bolder than the main body of the text.

The other changes are for the most part a word here and a phrase there, seemingly designed to make the text more readable and more up-to-date. A few cuts have been replaced by others more satisfactory. It is unfortunate that the older half-tones are beginning to show wear.

One concession to the war was noted. A cut of one of the "most revered" scientists, Dr. Noguchi, has been replaced by one of the "most revered" scientists, Major Reed. This reminds one of the anti-Wagnerian movement during the last war rather than of a calm, tolerant scientific attitude called for in the book's preface.

It was with disappointment that this reviewer found no change in the one section most needing revision, the chapter on weather. With recent marked advances in this science, together with the emphasis upon meteorology in aviation, it is to be regretted that this otherwise excellent book has not kept abreast of the times. The study of weather in the manner of twenty-five years ago is no longer sufficient.

To a lesser extent the same may be said of the section containing the study of the airplane. The airplane has become too important a factor in our lives to be brushed off in a few pages with the treatment of a decade ago.

WALTER A. THURBER

ELEMENTARY GENERAL SCIENCE, Book III. Edited by J. M. Harrison, *Senior Science Master, Bristol Grammar School,* Cloth. Pages 247. 12×18.5 cm. 1941. Longmans, Green and Co. Ltd. London. Price $1.60.

This English school book should not be confused with American elementary science texts. It is the third and last of a series for English Grammar Schools. This places it on a level with general science texts for our senior high schools.

The book is a pleasing contrast to our voluptuous science texts which seem always to touch upon more and more topics and to be more and more lush with extravagant half tones. The charm of the book is its simplicity; one must not be misled by its paucity of illustrations, the poor quality of its half tones, and its small size. The book has the direct appeal of "do-it-yourself" science books.

Experiments receive the emphasis in this book instead of being relegated

to paragraphs of fine print or to the teachers' manual. Discussion and explanation are given an important, but no more important, position than experiments. If this reviewer interprets correctly, this is the philosophy of science education put in practice rather than put in the preface of a book.

It is probable that only more advanced ninth grade pupils could use the book, but it would be a distinct challenge to them. There is much more chemistry, including organic chemistry, than we are accustomed to give despite the importance of chemistry today. The subjects of heat, energy, and machines are treated mathematically, although there are not many practice problems given; such are apparently left to the teacher.

Teachers looking for a book for an advanced general science or for a so-called "senior science" class might find this ideal for their needs. Its contents could be considered the minimum essentials of the course, upon which may be built according to the interests and needs of the class. Such a course would meet standards about which none need complain.

WALTER A. THURBER

MATHEMATICS DICTIONARY, compiled from the literature and edited by Glenn James, *Associate Professor of Mathematics, University of California at Los Angeles*, assisted by Robert C. James, *Teaching Fellow in the California Institute of Technology*, Revised Edition. Fabricoid. Pages viii+273+appendix of 46 pages. 15.5×23.5 cm. 1943. The Digest Press, Van Nuys, California. Price $3.00 (flexible or non-flexible covers).

This book attempts to define, in both the popular and the technical sense, all important mathematical words and phrases encountered in mathematics and its applications from arithmetic through the calculus. The definitions are in general such that they can be understood and used by the student who may have need for them, for example, *rectangle* is defined in terms which a junior high school student might comprehend; *curvature* is defined in terms which require a knowledge of calculus. This reviewer would question, however, that the dictionary is (as is stated in the book) a *condensation* of some ten subjects. Some definitions are included which cover work beyond the calculus.

Definitions are often supplemented by examples and illustrations; the appendix contains several numerical tables, a table of integrals, and a list of mathematical symbols.

No doubt many teachers will not agree with every definition (perhaps this may help standardize usage); it is possible to find terms which are not covered in the dictionary; nevertheless this is the only book of its type. It does not pretend to be an encyclopedia—it is a dictionary. It would be hard to see how the librarian of any school or college library could refuse to add this volume to the reference collection; likewise it should be one of the first additions to a mathematics library.

CECIL B. READ
University of Wichita

AN INTRODUCTION TO PLANE GEOMETRY, *with many examples*, by H. F. Baker, Sc.D., LL.D., F.R.S., *Emeritus Professor of Astronomy and Geometry and Fellow of St. John's College in the University of Cambridge.* Cloth. Pages viii+382. 15×22.5 cm. 1943. Cambridge: at The University Press; New York: The Macmillan Company. Price $4.00.

An American text with this title would probably be adapted to the mathematical maturity of high school students. The content of this book is material usually given to college juniors or seniors (and in some parts, to graduate students) in the United States.

The subject matter is treated without the use of a metrical axiom, and imaginary elements have equal standing with real elements. Since in a plane of real points imaginary points cannot be shown in a diagram, the representation is symbolic, and diagrams are relatively few.

Some idea of the range of material covered may be given by selecting a few topics at random: Duality, Desargues' Theorem, harmonic ranges, Feuerbach's theorem, projective ranges and pencils. There is a large number of examples, some of which will test the ability of the reader. Numerous notes and references offer suggestions for consultation of additional authorities, in particular one often finds where a theorem originally appeared.

In some portions of the book the print seems rather small but in general the typography is excellent. A trivial typographical error was noted in the table of contents.

CECIL B. READ

DIFFERENTIAL AND INTEGRAL CALCULUS, by Clyde E. Love, Ph.D., *Professor of Mathematics in the University of Michigan.* Fourth edition. Cloth. Pages xv+483. 16×24 cm. 1943. The Macmillan Company, New York, N. Y. Price $3.25.

Since this is a new edition of one of the most widely used calculus texts, it will probably be sufficient to indicate changes. This edition is larger in page size, and contains approximately 100 additional pages. The number of illustrative examples has been greatly increased, and numerical tables have been added (five place natural logarithms; natural and logarithmic hyperbolic functions; four place natural and logarithmic trigonometric functions). Topics which are new or noticeably expanded include: approximate solution of equations; hyperbolic functions; discontinuities; fluid pressure; approximate integration; indeterminate forms.

Although the author points out the difficulty in obtaining new exercises, it seems that it might have been possible to at least change the numerical values of data where problems were taken from previous editions. Selecting a set at random (time rates), the previous edition had 33 problems, this text has 35. Of these, 26 are identical, five are the same except for changes in numerical values, and four are new problems. Certainly if this is a fair sample the new edition will not solve the problem of fraternity house collections of complete solutions to all the exercises which have ever been assigned.

The subject matter has been rearranged by placing a chapter on integration early in the text. However, for those who prefer complete separation of differential and integral calculus, the chapters on differential calculus contain no material involving integration. Whether or not this is to be desired instead of being a compromise in an attempt to satisfy different viewpoints is a question best answered by the individual instructor in the light of the particular course he is teaching.

CECIL B. READ

MEASUREMENT AND EVALUATION IN THE SECONDARY SCHOOL, by Henry A. Greene, *Professor of Education and Director of Bureau of Educational Research and Service, University of Iowa,* Albert N. Jorgensen, *President, University of Connecticut,* and J. Raymond Gerberick, *Associate Professor of Education and Director of Bureau of Educational Research and Service, University of Connecticut.* Cloth, Pages xxiv+670. 1943. Longmans, New York. Price $3.75.

This book is an excellent revision of Greene and Jorgensen's "The Use and Interpretation of High School Tests." The historical background and

development of the testing program is quite adequately treated. Of special interest is the addition of a chapter on Personality Testing, as well as testing in physical and health education and in business education. The entire tone of the work is practical, and while the field of Educational Measurement is already burdened with books, the direct and straightforward nature of *Measurement and Evaluation in the Secondary School* makes it a valuable addition to the field. The statistical treatment of data is more extensive than that found in most books of this sort. It should be of considerable interest to students of Education, as well as those engaged in teaching or supervision at the secondary level.

JOSEPH G. PHOENIX
De Paul University
Chicago, Illinois

NUMBER READINESS SERIES, by Harold G. Campbell, *Superintendent of Schools, City of New York;* F. Lynwood Wren, *Professor of the Teaching of Mathematics, George Peabody College for Teachers;* and Worth J. Osburn, *Professor of Education, University of Washington.* Discovering Numbers, Grade III, pages vii+280. Number Experiences, Grade IV, pages iv+248. Number Activities, Grade V, pages viii+247. Exploring Numbers, Grade VI, pages vii+264. Cloth. 12.5×20 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 80 cents each.

This series of books is planned to develop interest in arithmetic by means of meaningful experiences and to prepare the child with the foundation for acquiring skill of the arithmetic processes. The authors have considered as a basis for organizing the books the interest, methods, content, maturity, reading ability and experience of the child. Adequate drill and practice exercises, interesting life problems, tests and vocabulary are contained which are particularly appealing from the teachers' standpoint. The attractive water-proof bindings and colorful illustrations will prove most fascinating to the child as well as being quite durable.

MARIE SHIELDS

PINE STUMPS YIELD GAS SUBSTITUTE

Fukien Christian University is now making contributions in two fields where previous shortages have handicapped Free China's defense efforts: in food and in fuel. Both shortages have directly resulted from the China Sea and Burma Road blockades.

United China Relief reports that Fukien University's chemistry department is responsible for a revolutionary new process, now a Chinese military secret, whereby crude oil and a gasoline substitute can be extracted from old pine tree stumps. By this process, perfected by a young chemistry instructor, use is made of the hundreds of thousands of tree stumps left in Fukien Province's forests as a result of its long history of timber exportation. The gasoline substitute is being used by the Chinese Army.

Food shortages in Fukien have been alleviated by the College of Agriculture's vast wheat-breeding experiments, in which 100 varieties taken from all parts of the world are now being grown throughout the province. The agronomists have also perfected two new varieties of rice which yield 40 per cent more than the native local variety.